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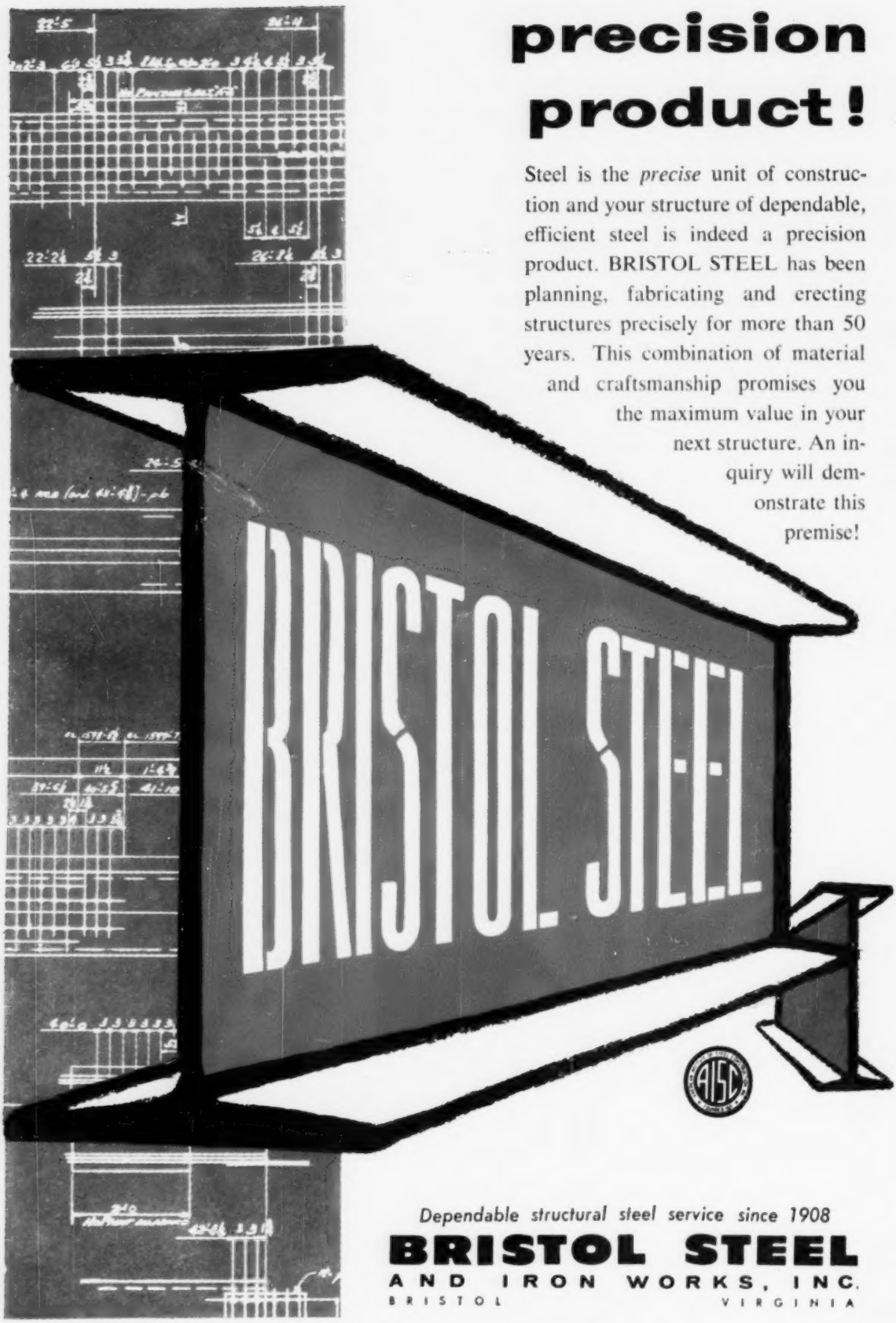

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CIVIL ENGINEERING

DECEMBER 1960

VOL. 30 • NO. 12

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CONCRETE PERFORMANCE REPORT:

POZZOLITH lends 5000 psi concrete high degree of workability in interesting new structure

Phillip Johnson's new Munson-Williams-Proctor Institute Art Gallery in Utica, New York, features a unique structural system. In it, Dr. Lev Zetlin's use of engineering theory and imagination combine to produce a building of outstanding practicality. Many catch-phrase titles have been applied to the prestressed concrete structural system, which Dr. Zetlin himself calls a "two-way lattice girder". Others, after a glance at the huge monolithic system of two parallel pairs of concrete beams which intersect at right angles to form a single monolithic girder, have mentioned its resemblance to a gigantic game of tic-tac-toe.

Actually, the *monolithic structural system* of cast-in-place, post-tensioned concrete is completely functional, and results in an interior free of supporting columns. The four sections were monolithically cast in one huge concreting operation and are supported only at their extremities. According to Dr. Zetlin's computations, the resulting single girder provides a strength and rigidity equal to eight similar parallel girders, or *sixteen 2′ x 2′ interior columns.*

This huge girder, consisting of four 123′10″ sections, was cast-in-place more than fifty feet above grade. Within their 10′9″ x 22″ cross-section, each of its four sections contains 14 flexible, hollow conduits for the post-tensioning cables, four 4″ hollow sleeves for balcony rods and several types of reinforcing bars in diameters up to ½″.

This complexity of steel, coupled with the need for a continuous placement of concrete to provide a truly monolithic girder, required special considerations in the design of concrete. Dr. Zetlin's structural system required a concrete mix which met these four specifications:

First, 5000 psi compressive strength for economical utilization of prestressed concrete and to meet the prescribed design loads.

Second, to assure a monolithic member completely free of horizontal cold joints and honeycombing, the hardening of the mix had to be retarded.

Third, a high degree of workability was required because of the complexity of steel reinforcement and delicate positioning of conduits within each section.

Fourth, a low unit-water content for minimum shrinkage and over-all improvement of concrete quality.

Cooperative effort by the local Pittsburgh Testing Laboratory, the Alpha Portland Cement Company and the local Master Builders field men, developed the following mix design:

Type I Alpha Portland Cement—	668 lbs.
Sand—	1240 lbs.
#1 Stone—	550 lbs.
#2 Stone—	1280 lbs.
Water—	32 gals.
POZZOLITH Retarder—	1.78 lbs.

The mix had excellent workability and was easily placed with only 3½″ slump. It contained 20% less water than a comparable plain mix. A companion mix with 2½″ slump was also designed for use during later stages of placement to insure equal rate of hardening.

Placing operations began at 8 a.m. with two crews of the George A. Fuller

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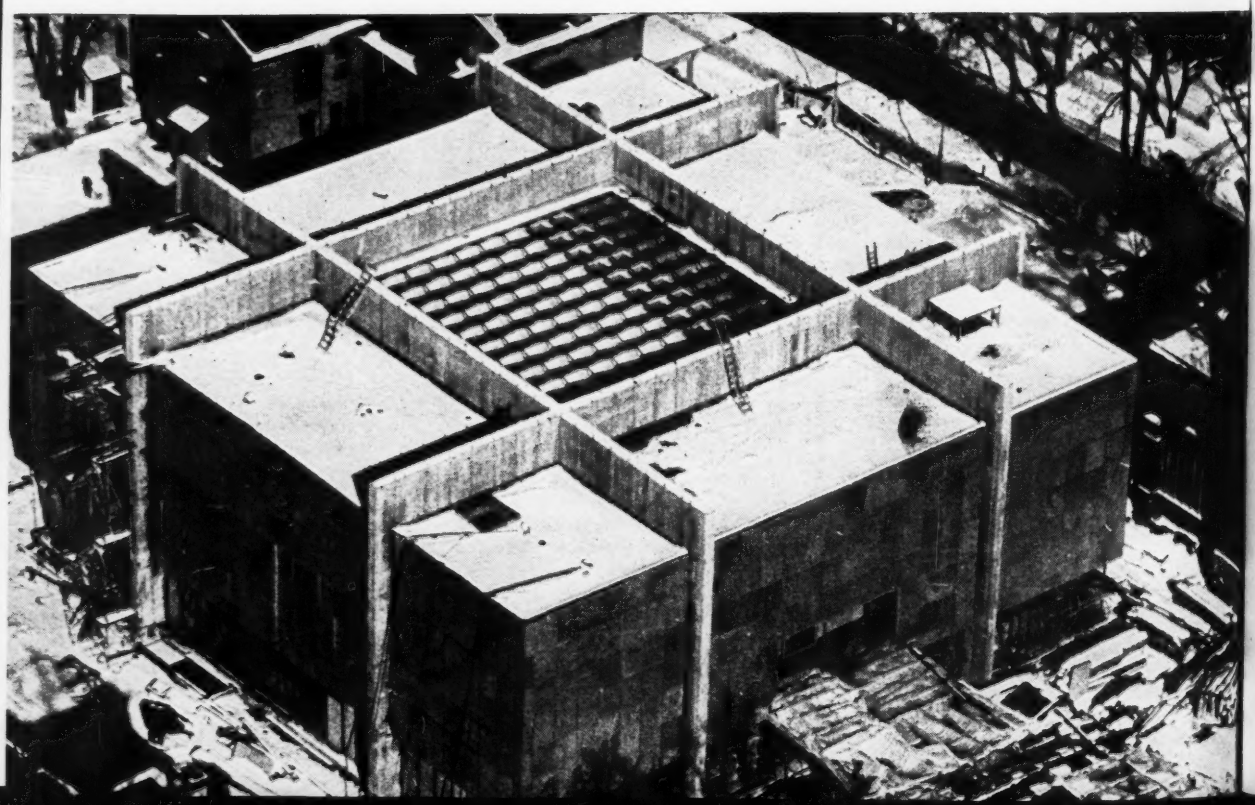

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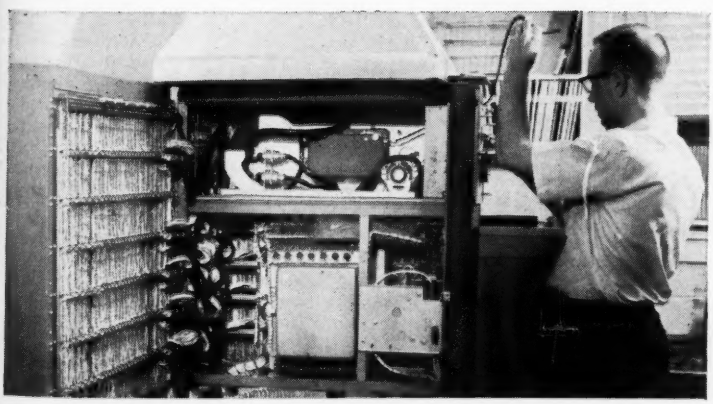

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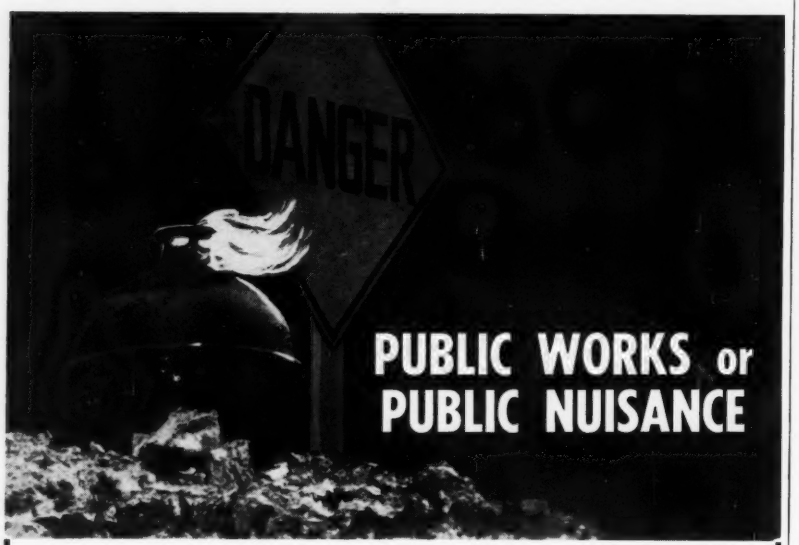
NEWS OF MEMBERS

Harry D. Claybrook, after 11 years as structural engineer with the Nashville architectural firm of Marr & Holman, has joined the Portland Cement Association as general field engineer with headquarters in Nashville. While with Marr & Holman, Mr. Claybrook did design work on the Vanderbilt Medical Arts Building, the Madison Square Shopping Center, and the Nashville city auditorium.

Jack B. Blackburn has joined the engineering faculty at the University of Arizona for the academic year 1960-1961. A specialist in highway engineering, Mr. Blackburn will serve as director of the Arizona Transportation and Traffic Institute in addition to his duties as professor of civil engineer. **Howard Harrenstein,** a former staff member of Iowa State University where he did considerable research on hyperbolic paraboloidal roof structures, has also joined the University of Arizona staff as associate professor to teach graduate-level structures and engineering mechanics courses.



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Emil A. Gramstorff was honored recently with a testimonial dinner in recognition of 39 years of service to Northeastern University. From 1939 to 1954 chairman of the civil engineering department, he has been dean of graduate study in engineering since the latter year. Dean Gramstorff is a past president of the Massachusetts Section.

Louis K. Whitcomb, until recently manager of product development with the Sharon Steel Corporation, has been named director of market research at the Wheeling Steel Corporation.

H. J. Dickinson, for the past four years construction engineer with Tipton and Kalmbach, Inc., on tunnel and dam construction for the Denver Water Board, and **A. R. B. Edgecombe,** a partner in Haigh, Zinn and Edgecombe, consulting engineers of London, who has spent many years in the Near East and the sub-continent, have been assigned as assistants to the project manager on the Link Canals Project in West Pakistan. **Lyman R. Flook** of the Denver design staff of Tipton and Kalmbach has also been transferred to the Link Canals Project.

Charles H. Sells, announces the opening of a new office of Chas. H. Sells, Inc., at 61 Maple Avenue, New City, N. Y. The firm's other offices are at Pleasantville, New York City, and Rochester, N. Y.

R. Robinson Rowe, at the present time in charge of special studies for the California Division of Highways as principal bridge engineer, retired on November 30 after an engineering career covering 40 years, 26 of them in state service. Co-author of a widely-known book, "California Culvert Practice" and co-ordinator of a recent study of slides in the Pacific Palisades area in Los Angeles, his most recent research project involved the compilation of a treatise on stream bank protection based on cooperative studies. He is probably best known, however, as the author of the "N. G. Neare's Column" a mathematical puzzle feature which appeared in CIVIL ENGINEERING from 1940 to 1960 and his current column "Examgems" which he authors under the name of "Reggie Strashn." Mr. Rowe was director of ASCE from 1956 to 1958.

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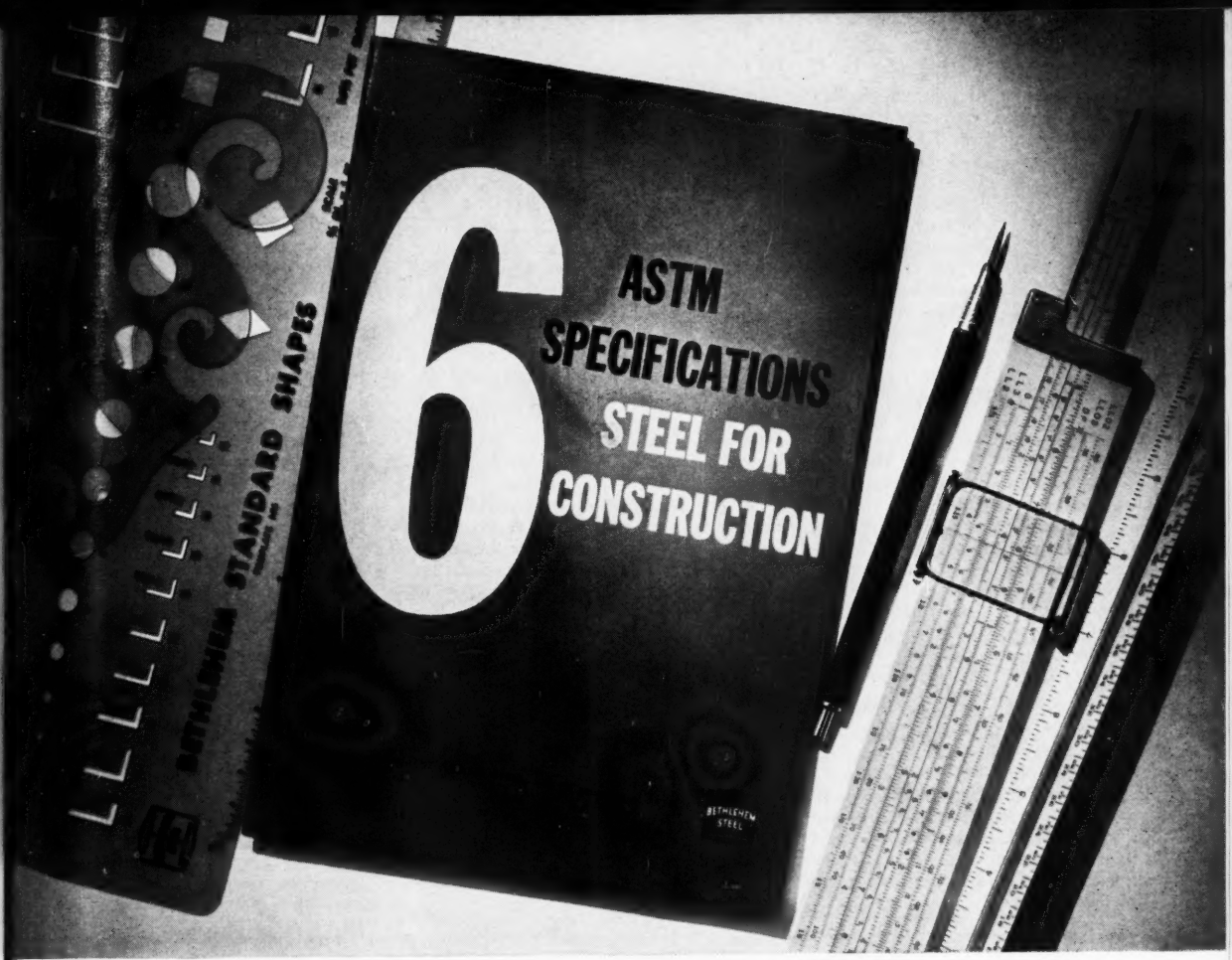

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Carter Page, one of the nation's outstanding authorities on water resource development, retired on October 15 as chief of the Planning Division, Office of the Chief of Army Engineers, after 31 years of Federal service. In recognition for his long service—he worked on initial flood control studies that contributed to passage by Congress of the first general flood control act in 1936—Mr. Page was given the Department of Army Sustained Performance of Duty Award in 1954 and again in 1956. For his military service during World War II he received the Army Commendation Medal with Oak Leaf Cluster, the Bronze Star, the Legion of Merit with Oak Leaf Cluster, the French Croix de Guerre, and the rank of Colonel. Mr. Page expects to remain in the Washington area as a consultant on water resources.

Everett A. Hansen, Colonel, Corps of Engineers, for the past three years district engineer at Galveston, Tex., has been appointed vice president in charge of engineering for the Bauer Dredging Company, Inc., of Port Lavaca, Tex. In the past he has served as chief of the topographic branch of the Army General Staff in Washington; as assistant Omaha district engineer; as assistant district engineer in Iceland; as resident member of the Beach Erosion Board; and as engineer comptroller in the Office of the Chief of Engineers.

Albert H. Baum, after 19 years as city building commissioner of St. Louis, Mo., retired on October 31. Consultant to the group that recently completed drawing up a new building code for St. Louis, Mr. Baum over the years has sponsored a number of technical codes for the city.

George A. Kiersch has joined the faculty of Cornell University, Ithaca, N. Y., as professor of geology to teach courses in structure, sedimentation, and engineering geology. Dr. Kiersch has participated in many engineering projects throughout this country and abroad, and for the past five years has directed a special geological program for the Southern Pacific Company, San Francisco. He will continue his consulting practice in engineering geology and industrial materials.

Charles W. Thoma, formerly vice president of operations with the Scott Engineering Company, Watertown, S. Dak., is a partner in the new firm of Stitzel & Thoma with offices in the AC Office Building, Suite 412, Arkansas City, Kans.

Cornell University's School of Engineering was well represented in Europe last summer. **Marvin Bogema,** of the department of hydraulics, represented Cornell in a conference on flow measurements in closed conduits, held at National Engineering Labs, Glasgow, and afterwards visited the National Research Station at Wallingford, England. About the same time **George Winter,** head of the structures department, was in Stockholm to present his "Current Trends in Steel Building Design" to the Sixth Congress of the International Association for Bridge Structural Engineering; **Arthur J. McNair,** head of the surveying department, presented a paper at the meeting of the International Society of Photogrammetry in London; and **John Rogers,** of the department of administrative engineering, toured five European countries studying new construction techniques and methods.

W. A. McElhannon has been promoted from designing engineer to senior supervising engineer in the technical department of the Cracking and Light Ends Division at the Baytown, Tex., refinery of the Humble Oil & Refining Company's Humble Division. At the present time Mr. Elhannon is teaching courses in statics for engineers, for the second year, at Lee College, Baytown.

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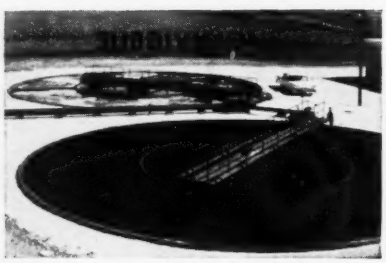

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George D. Whitmore, chief topographic engineer of the U.S. Geological Survey, was elected a member of the seven-man Council which governs the International Society of Photogrammetry at the recent Ninth International Congress on Photogrammetry, in London. He is also the current chairman of the Committee on Topographic Maps and Aerophotogrammetry under the Commission on Cartography of the Pan American Institute of Geography and History, and U.S. member of the Working Group on Cartography, Special Committee on Antarctica Research, International Council of Scientific Unions.

George F. Stevenson, a 30-year veteran with the Louisiana State Highways Department, succeeds **E. J. James** as the department's chief engineer. Named to his current post of bridge construction engineer in 1959, Mr. Stevenson started there in 1931 as an instrument man. Mr. James, who has been with the department for 33 years, and has served as chief engineer since 1952, will become urban engineer for the department.

Harold G. Arthur assumed new duties as assistant director of Region 6, U.S. Bureau of Reclamation in Billings, Mont., recently, after 15 years in the Bureau's Denver, Colo., office. His last ten years there were as supervisor of the design unit of the Earth Dams Section.

S. S. Steinberg, president of the Instituto Technologico de Aeronautica in Brazil, was recently decorated by the president of Brazil with the highest civilian award, the Order of Merit, "for outstanding services to the Government of Brazil."

Felix A. Ciampa, due to the dissolution of the partnership of Youngson & Ciampa, has opened consulting offices at 4 Albany Street, New York, N. Y. The firm's structural engineering activities will encompass commercial, industrial and institutional buildings; foundations, piers, bulkheads and waterfront improvements.

Leonard E. Van Houten, who is presently in charge of Frederic R. Harris' office in The Hague, Holland, has been made a vice president in the firm. His past professional experience includes several projects in Venezuela as project manager of the Creole Petroleum Corporation; work for the Aluminum Company of Canada, Ltd., as a design and project engineer; and work for the Jones & Laughlin Steel Company as a resident consulting engineer.

(Continued on page 28)

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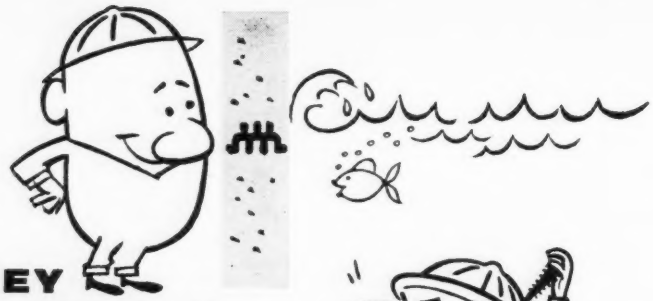

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Louis H. Oppenheim, since 1938 a member of the Kaiser organization, has been named a vice president of Kaiser Industries Corporation. At the same time **Franklin T. Matthias** was promoted from manager of heavy construction for Kaiser Engineers (October 1960 issue) to vice president of the Henry J. Kaiser Company. Mr. Oppenheim is currently general manager of Kaiser Engineers and a vice president of the Henry J. Kaiser Company.

Paul E. Morgan, associate professor of civil engineering and **E. Robert Baumann,** professor of civil engineering at Iowa State University, have undertaken a three-year study of design requirements for municipal diatomite filters under a $56,571-grant from the National Institute of Health of the U.S. Public Health Service. Professor Baumann only recently returned to Iowa State after completing a year of postdoctoral study under a National Science Foundation Science Faculty Fellowship at the University of Durham, Kings College, England.

Nathan L. Weis has been elected president of the Interstate Construction Corporation of Kansas City, Mo. Mr. Weis, for the past six years a vice president,

N. L. Weis

W. Guinn

has been with the Corporation since 1946. Another veteran staff member, **Wright Guinn,** a vice president since 1956, was reelected to that post.

John S. Archer, formerly project structures engineer of the structural dynamics group, Convair Division, General Dynamics Corporation, Fort Worth, has joined Space Technology Laboratories, Inc., at Los Angeles. Mr. Archer will serve on the technical staff in the engineering mechanics department of the Dynamics Section.

Richard L. O'Connell, new appointee to the staff of the Robert A. Taft Sanitary Engineering Center of the U.S. Public Health Service, in Cincinnati, Ohio, will engage in radiological water pollution field investigations there. His most recent position was as project engineer of the San Francisco Bay Barrier Project, part of a $3 million comprehensive survey of San Francisco Bay and tributaries.

Fred W. Beaufait will teach for a year at the University of Liverpool, England, under an instructor exchange program. During the 1959-1960 school year, while working towards his master's degree, he was a part-time instructor in the University of Kentucky Department of Civil Engineering and worked with a consulting firm in Lexington.

(Continued on page 102)

. . . . . *Am-Soc Briefs*

▶ ▶ Convention calendar. . . . With the Boston Convention already a pleasant memory, the spotlight is on Phoenix, setting for the next ASCE Convention, April 10–15. Phoenix is famous as a taking-off point for sightseeing, and the desert will be in bloom in April. . . . The program theme is water resources, and all the Technical Divisions are organizing their sessions to highlight water, perennially a vital subject in the dry Southwest. . . . With only two Society Conventions scheduled for 1961, the Phoenix Convention will combine important features of the usual Winter and Summer Conventions.

▶ ▶ Overseas units. . . . Under a policy recently adopted by the Board of Direction, ASCE members living in foreign countries may form Overseas Units as a medium for professional and social get-togethers far from home base. The first such unit has now been established in Australia (story on page 77).

▶ ▶ Two new presidents. . . . ASCE is interested in two recent elections -- James N. Landis as president of Engineers Joint Council and Willis F. Thompson as president of United Engineering Trustees. EJC President Landis is vice president of the Bechtel Corporation, San Francisco, and widely known as an authority on power. UET President Thompson is executive vice president of Westcott and Mapes, New Haven, and a leading mechanical engineer. As chairman of the UET Real Estate Committee for the past several years, Mr. Thompson has been a driving force in fund raising for the new United Engineering Center.

▶ ▶ For sale. . . . The papers presented at the Second Conference on Electronic Computation, held in Pittsburgh last September, are now available in a single volume. The special hard-bound edition includes the thirty-two technical papers, the welcome and keynote addresses, and three luncheon talks. For convenience in ordering, a coupon is provided on page 134.

▶ ▶ Free to authors. . . . Available for the asking (upon application to headquarters) are two new guides to writing for ASCE publications. They are "Author's Guide to Publications of the American Society of Civil Engineers" (1960–35), and "Division Officers' Guide to the Publications of the American Society of Civil Engineers" (1960–36). This one is expressly for Division reviewers. Both replace outmoded guides.

▶ ▶ A special highway issue will launch the 1961 "Civil Engineering" year. Emphasis will be on latest design and construction techniques and freeway developments.

Concrete adhesives and mortars with **THIOKOL** polysulfide polymer

MAKE LITTLE OF BIG REPAIRS

STRUCTURAL. Polysulfide-modified concrete adhesives join new concrete to old—or rejoin old sound concrete—with a *watertight* bond that's stronger than concrete itself. They have wide use in vertical building. Their application on this fire-damaged marine terminal (gutted concrete sprayed with adhesive then new concrete poured) avoided complete reconstruction, saved the city years of time and millions of dollars in remedial costs.

ROADWAYS. Polysulfide-modified mortars patch potholes and fill ruts and dips. In this application, adhesive and aggregate are mixed in a ratio of 1 to 5, spread and troweled like concrete. Digging down to bedrock or exposing steel reinforcements and pouring new concrete (conventional repair techniques which tie up traffic for days) is avoided. Polysulfide-modified mortar cures fast. Time, labor and the public temper saved.

FLOOR PATCHING. In plants where regular concrete has broken down under exposure to abusive traffic, chemicals or corrosive agents, mortars with THIOKOL polysulfide polymer have stood the test of time and wear.

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do you know that

Bond issues for $3.2 billion worth of construction were approved in the November elections? Projects to which voters gave the green light include California's $1.75 billion Feather River Water Project; $356.2 million for school construction and $250.5 million for colleges and universities; $201.5 million for sewage treatment and disposal facilities; $119.9 million for highways; $22.4 million for urban redevelopment in four cities; and $11.2 million for flood control in five cities. Faring badly were proposals for public buildings and recreational facilities.

▪ ▪ ▪

Civil engineers and constructors proved themselves vote getters? Victorious ASCE members in the November polling were George D. Clyde, civil engineer and water authority, who won reelection as governor of Utah by a narrow margin; Charles Willet, consulting engineer of Dixon, Ill., who won a seat in the state House of Representatives; and Daniel J. Evans, consulting engineer of Seattle, reelected to the state House. Veteran contractor John A. Volpe, president of the Associated General Contractors of America, was elected governor of Massachusetts by a wide margin.

▪ ▪ ▪

Air pollution is one of the nation's major problems? To help solve it, both government and private industry will double their spending for research in the next eight years. Federal spending will be increased from $5 to $11.5 million, state spending from $2 to $7.5 million, and industry's share from $4 to $6 million.

▪ ▪ ▪

Millions of Russians are studying English? A report by the Modern Language Association puts the number between 5 and 10 million. In sad contrast, only about 19,600 American high school and college students are studying Russian. In a step-up in foreign language teaching, the Soviets are offering English and other foreign languages at second-grade level instead of in the fifth grade, as in the past. English is said to be by far the most popular foreign language, followed by German, and then French or Spanish.

▪ ▪ ▪

A buzzer to arouse dozing drivers, or help them locate the edge of the road is a future possibility? The buzzer—demonstrated by General Motors engineers at the annual meeting of the Highway Research Board—is part of a low-frequency electromagnetic system using loops of wire that could be installed in or along any paved road. Cars would be equipped with pickup coils hanging from either side of the front bumpers.

▪ ▪ ▪

Cholera still rages in Asia? In 1959 there were 42,000 cases—all easily preventible, according to Purdue University's "Sanitary Engineering News." In this travel-minded day, the existence of Asiatic cholera anywhere on earth is a distinct threat to the health of all. Government recognition of the perennial hazard of polluted water has taken the form of a National Water Pollution Conference, called by the President for December 12-14 in Washington.

▪ ▪ ▪

Highway deaths were up in 1959? Fatalities climbed to 37,600 (an increase of 900 over the preceding year), and more than 2,870,000 were injured (an increase of more than 50,000 over 1958). Statistics compiled by the Travelers Insurance Companies cite speed as the biggest single cause of accident, accounting for 43.1 percent of the deaths and 38.8 percent of the injuries. Second biggest killer was the driver on the wrong side of the road, who was blamed for 15.9 percent of the deaths. Since the automobile first appeared on the scene, the report says, it has been responsible for more than 62,000,000 casualties.

▪ ▪ ▪

The Bureau of Reclamation reports some success in its battle against evaporation and other water losses? The success is in improved weed control on irrigation projects, where savings of at least $15.8 million in water losses have been recorded. In another phase of the same program, the Bureau has signed a contract with the Arizona State University at Tempe to carry out investigations on the interrelation between wind and water waves, and evaporation-reducing chemical films on water surfaces.

▪ ▪ ▪

Rising population and delays on the Aswan High Dam are troubling Egypt? With full benefits from the dam, its power plant, and its irrigation system not expected for fifteen years, Egyptian planners fear it will be a close race between engineers and the birth rate. At the present rate of population increase, there will be between 6 and 7 million more mouths to feed before the dam is ready to raise the standard of living. Delays in starting the dam are attributed to the time consumed in getting decisions from far-away Moscow and to changes in design and methods that are, however, expected to save time in the long run.

▪ ▪ ▪

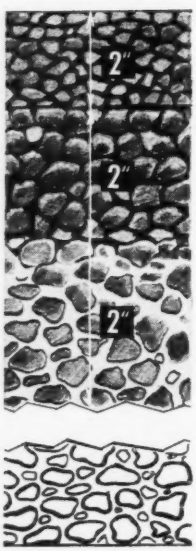
Top-caliber career women in federal service will get their day in the limelight? Six outstanding career women will be honored annually with a new "Federal Woman's Award," to be administered under the Civil Service Commission. Selections will be made by a board of trustees, and Federal agencies have been notified to submit nominations for this year's awards (to be made late in February) by December 9.

FOUND!

A winning combination: Asphaltic concrete made with Chevron Asphalt over a Dilute Bitumuls Treated Base.

For "Deep-Strength" Construction PLUS Economy!

Realignment of U. S. Route #99 (Pacific Highway) between Albany and Eugene, Oregon, involves construction of twelve miles of new, heavy-duty pavement.



4 inches Asphaltic Concrete made with Chevron Asphalt; laid in 2 lifts as indicated.

Top 2 inches of crushed stone base treated with diluted Bitumuls; then compacted.

Compacted base stone

The original "specs" called for construction of a compacted stone base, surfaced with 4 inches of asphaltic concrete. As a result of preliminary tests, however, a Field Change Order was issued specifying treatment of the top 2 inches of the base with an economical nine-to-one dilution of Bitumuls.

Dilute Bitumuls Treatment "controlled" the top of the base during surfacing; provided water-resistance that contributed to an overall stronger pavement. Over the base, two lifts of asphaltic concrete made with Chevron Asphalt were placed to complete the construction.

The job is under the direction of the Oregon State Highway Department. The contractor, Warren Northwest, Inc., has done a fine job of coordinating all phases of the job. One key factor in maintaining operations on schedule has been the dependable, on-time service on Bitumuls and Chevron Asphalt deliveries.

Call office nearest for details on how Bitumuls Emulsified Asphalts and Chevron Paving Asphalts can be combined to give you better pavements at lower cost.

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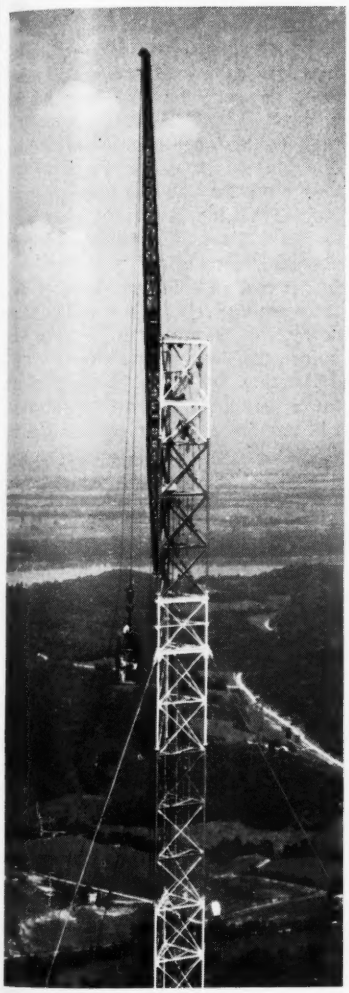
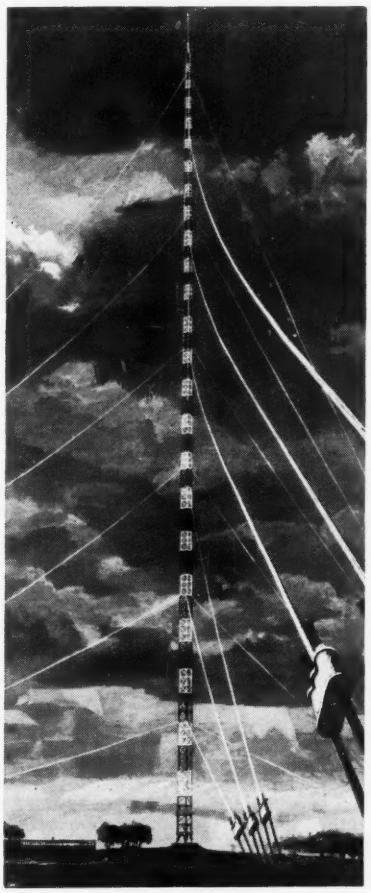
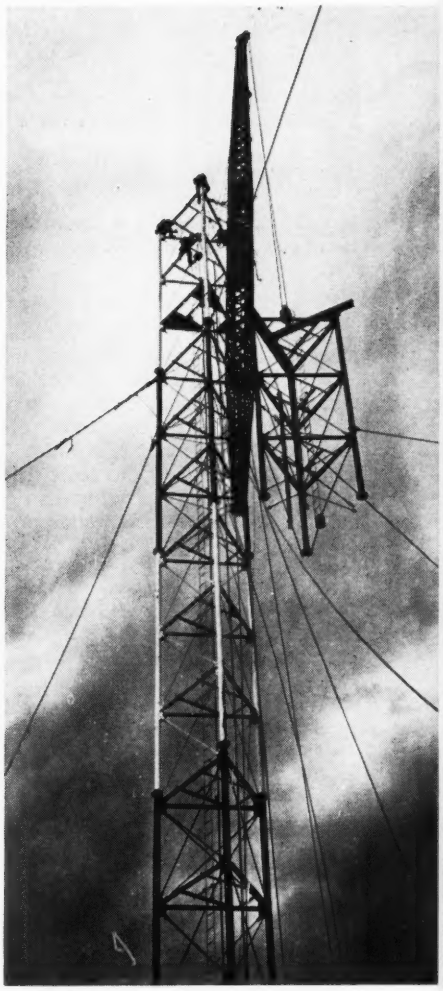
WORLD'S TALLEST STRUCTURE



Workmen avoid a long climb by riding up in a cage swung from the gin-pole.



The tower is held by 18 guy lines to anchorages placed 120 deg apart.



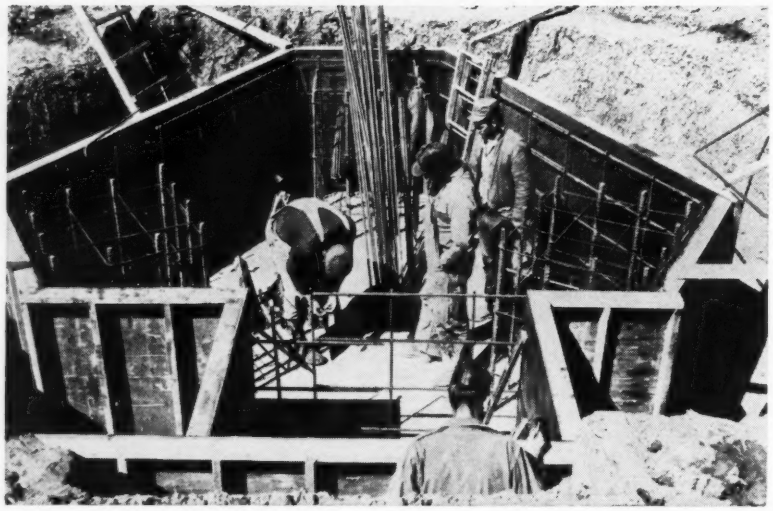
A 30-ft section of tower is being raised as a unit to be set on the structure.

ORVILLE PELKEY, Manager of Engineering; **AUSTIN C. WOODWARD,** Manager of Tower Design

Tower Division, Dresser-Ideco Company, Columbus, Ohio

With the recent completion of a television antenna tower at Cape Girardeau, Mo., the world has gained a new "tallest." Designed and fabricated by Dresser-Ideco Company for Station KFVS-TV, the Cape Girardeau tower is 204 ft taller than the Empire State Building and 692 ft taller than the Eiffel Tower.

Since TV signals travel in a straight line from the antenna out to the horizon and then out into space, tall tow-



World's tallest tower has a small foundation. Vertical load, including reaction from tower guy lines, is 1,836,000 lb.

ers are a necessity for television transmission. Increasing the height of the antenna increases the line-of-sight distance to the horizon, the area covered by the signal, and the number of people reached. In the case of KFVS-TV, its new 1,676-ft tower has more than doubled the station's coverage. Its signal now reaches over 2,000,000 people in an area of 31,800 sq miles, or roughly a circle 200 miles in diameter.

Tower design

The tower was designed for a wind load of 50 lb per sq ft on flat surfaces and 33.3 lb per sq ft on round surfaces. This is equivalent to a wind velocity of 109 miles per hour with a gust factor of 1.25.

The tower is triangular in cross section, with solid round steel legs spaced 10 ft apart. The legs are made of high-strength MAN-TEN steel with a maximum diameter of 7¼ in. These legs were fabricated in 30-ft lengths with round splice plates welded to each end. Each leg splice consists of six 1-in. standard machine bolts.

Tower diagonals are solid round steel rods varying in diameter from ¾ in. to 1⅜ in. The ends are welded to steel tie-plates which are bolted to the leg gusset plates with structural rib bolts and lock nuts from Automatic Nut Co., Inc., Lebanon, Pa. Diagonals are fabricated with a small amount of draw so that they will all be tight when the tower is erected.

The main horizontal girt members are double angles varying from 2½ in. x 2 in. x 3/16 in. to 3 in. x 3 in. x ¼ in. They are also connected to the gusset plates with structural rib bolts.

Several important features are to be noted in the type of construction selected for this tower. Round members are used wherever possible because the wind load on a round member is only two thirds of that on a flat member. All round members are solid rods. Tubular members would be more economical for some parts of the tower, but they have one very serious fault. Their inner surfaces are subject to rust and corrosion besides being inaccessible for inspection and painting. In the case of solid members, all surfaces are visible and, if rusting occurs, corrective measures can be taken long before the damage is serious.

Another important feature of the tower design is the use of structural rib bolts in all shear splices that are subject to reversal of stress due to a change in wind direction. This arrangement eliminates joint slippage and resulting deformation of the tower.

Another design feature of the tower is its fixed base. Because this does not taper to a point at the top of the foundation it permits easy, direct installation of the transmission lines at the elevation that is most convenient for entrance to the transmitter building. The fixed base also allows the elevator machinery to be installed on the foundation and permits the bottom elevator landing to be closer to the ground than would be possible with a pivoted base. The fixed base also made erection easier because temporary guys were not required until well over 100 ft of the tower had been erected.

The tower is supported at six levels by guy cables. At each level three guys are used, spaced 120 deg apart. The guys are galvanized, prestressed bridge strand varying in diameter from 1 5/16 in. to 1¾ in. and in length from 832 ft to 2,065 ft. The total length of guy cable is slightly less than five miles. Stockbridge dampers are installed near the bottom end of each guy cable to control vibration.

A platform 4 ft wide surrounds the tower at the top elevator landing. In addition to this, inside platforms are provided at the level of each beacon and obstruction light for the convenience of maintenance personnel. An inside platform is also provided at the bottom elevator landing. A combina-

Copper strips 6 in. wide and 50 ft long were buried in a radial pattern at the tower base and at the guy-line anchorages to ground the structure for protection against lightning. On the right, the two-man elevator cage awaits installation.

tion catwalk and coaxial line support leads from this platform to the roof of the transmitter building. This permits convenient access to the tower from the building but, since there is no ladder below this level, unauthorized personnel cannot gain access to the tower. Inside platforms are also provided at the first and second guy levels to facilitate adjustment and maintenance of the microwave reflectors installed at these levels.

An elevator of 750-lb capacity as well as a ladder provide easy access to any part of the tower for maintenance personnel. Dual controls are provided so that the elevator can be operated either from the ground or from inside the car. The ladder is located adjacent to the elevator car door so that it is an easy step from the elevator to the ladder at any point on the tower. Over-travel limit switches and spring buffers are located at the top and bottom of the elevator travel limits. The car is supported by two cables, either of which will hold the car and its full load. An automatic safety feature locks the car to the guide rails in the event of cable failure.

For protection against lightning, the base of the tower and the six anchors are grounded. Copper strips 6 in. wide and 50 ft long are buried in a radial pattern around the tower base and around each guy anchor. The inner ends of these radials terminate in copper caps which are placed over the tower-leg base plates and the ends of the guy anchors. The outer end of each radial is attached to a copper-clad ground rod ½ in. in diameter and 8 ft long.

The tower is provided with aircraft obstruction lighting in conformity with the requirements of the Federal Communications Commission and the Civil Aeronautics Administration. This consists of 1,000-watt beacons on the top of the antenna and at four intermediate levels, and three 100-watt obstruction lights at each of six intermediate levels. The lights are controlled by a photo-electric control, which automatically turns them on at sunset and off at sunrise. A lamp-failure indicator panel is also provided. There is a platform at each light level to give easy and safe access for bulb changes and other lighting system service.

The antenna is an RCA travelingwave, TW12A, Channel 12. It projects 81 ft 7 in. above the top of the tower and weighs about 8 tons.

The tower rests on a hexagonal reinforced-concrete pier 13 ft 8 in. between parallel faces and 4 ft 6 in. high. The load is distributed to the underlying rock by a hexagonal pad which is 20 ft between parallel faces and 2 ft 6 in. thick. This foundation utilized 61 cu yd of concrete. It supports the elevator machinery as well as the tower proper. Each of the three tower legs rests on a steel bearing plate 36 in. square by 4 in. thick.

The tower foundation is designed for a vertical thrust load of 1,836,000 lb, a horizontal shear load of 23,700 lb, and an overturning moment load of 892,000 ft-lb. The maximum soil pressure, under the above load, is 8,000 lb per sq ft.

Each of the three inner guy anchors consists of a block of reinforced concrete 8 ft wide, 14 ft long and 8 ft thick. The top of this block is 8 ft below ground level. A concrete neck, 3 ft 6 in. by 4 ft 6 in. in cross section, extends from the center of this block diagonally upward and toward the tower to a point above grade, where it terminates in a pair of ⅝-in. plates. The bottom ends of the three lower tower guys are attached to these plates by means of closed bridge sockets.

The inner guy anchors are designed for an uplift load of 310,000 lb and a horizontal load of 436,500 lb. These figures include a 100-percent overload factor. The anchors are placed at varying distances (772 ft, 819 ft and 836 ft) from the tower because of differences in ground elevation. The three inner guy anchors required about 141 cu yd of concrete.

Two different designs were required for the outer guy anchors because of differences in the soil. One anchor was designed for a maximum passive earth pressure of 2,000 lb per sq ft while the other two were designed for 4,000 lb per sq ft. These anchors are similar in shape to the inner anchors and are also located at varying distances (1,112 ft, 1,140 ft and 1,143 ft) from the tower.

The outer guy anchors are designed for an uplift load of 554,000 lb and a horizontal load of 478,000 lb. These loads also include a 100-percent overload factor. The three outer guy anchors contain a total of 234 cu yd of concrete.

Tower fabrication

All tower parts were fabricated at Dresser-Ideco's Columbus, Ohio, plant; no field fabrication was required. Base plates were welded to both ends of each 30-ft leg section, and gusset plates were welded to the leg members to accommodate horizontal girts and diagonal bracing. All parts fabricated were jig-fitted and welded into final components, and tagged to facilitate assembly at the site. Parts were shipped via rail from Columbus to Cape Girardeau, then hauled by truck to the summit of the 810-ft hill on which the tower stands.

Before erection began, service roads were bulldozed through virgin timber to the anchor areas, which are located on the hillside far below the base of the tower. Terrain around the plateau on which the tower stands is extremely precipitous—with grades as steep as 45 deg—and necessitated the use of tractors to pull concrete trucks into position and Missouri mules to haul guy cables out to their anchors. Tower components were assembled on the ground into 30-ft sections weighing about 18,000 lb each.

Erection methods

Lower sections were placed with a crane until a traveling gin-pole could be put in place. From then on, all rigging was done by means of the gin-pole and a power hoist, set at ground level. The gin-pole was kept outside the tower all the way up, first hoisting a section into place and then hoisting itself by its own bootstraps. Supported by cables tied to the tower frame, the rig reeled up on the cables to rise to a higher level. Four sections, on an average, were completely installed each day.

All the connections were bolted. No welding was done at the job site except at the antenna attachment to the tower; this point is subject to a large number of stress repetitions, which make a welded joint desirable.

Temporary guys were set for every three sections. As construction progressed, the permanent guys were strung, adjusted for initial tension, and the dampeners attached. The temporary guys were then removed. Before shipment, all permanent cables were prestressed in the factory. Calibrated hydraulic jacks, as well as "guy meters," were used in the field to insure correct tensioning.

The RCA Channel 12 antenna, which is 81 ft 7 in. tall and weighs approximately 8 tons, was assembled on the ground and hoisted to the top of the tower as construction neared completion. (See cover.) When the antenna had been set and fastened in place, erection was completed. The two-man elevator was then installed, and transmission lines and other electronic equipment were hooked up.

Design and fabrication of the Cape Girardeau tower were carried out by Dresser-Ideco Company, Columbus, Ohio. Erection was done by the Seago Construction Company, Dallas, Tex., under contract to Dresser-Ideco. Transmitters and antennas were supplied by Radio Corporation of America. The foundations were installed by Superior Concretors of Cape Girardeau.

Prestressed concrete resists fire damage

CHARLES C. ZOLLMAN, Partner; **MARCELLO G. GARAVAGLIA,** Engineer; and **AVIV RUBIN,** Engineer

Schupack and Zollman, Consulting Engineers, Newtown Square, Pa.

An opportunity to assess the damage that fire can do to a building with a frame of all precast, prestressed concrete recently occurred at Horsham, Pa., near Philadelphia. After the building had been gutted by a fire lasting several hours, a great many of the structural members were proved usable by simple and rapid means.

This single-story structure, of 150,000 sq ft, housed one of a chain of department-type stores known as "Bargain City, U.S.A." The fire broke out at about 2:00 a.m. on December 24, 1959, and was not brought under control until after 7:00 a.m.

Fed by a particularly large stock of Christmas merchandise, ranging from clothes and drygoods of all kinds to paints, carpets, and phonograph records, the fire spread rapidly throughout the store. No sprinkler system had yet been installed at the time of the fire nor were there any fire walls in the 200 x 750-ft building.

From information available to the writers, it would appear that the 150,000 sq ft of open selling space was rapidly filled with smoke. Flames in the center of the building forced firemen outside within 15 minutes of their entry. Eyewitnesses report that merchandise burst into flames from the intense heat, and that firemen were harassed with low water pressure. The nearest hydrant was some 2,500 ft away from the building. Water was pumped from the Willow Grove Naval Air Station, a half-mile to the north, and from Pennypack Creek, almost a mile to the west. No more than five hoses were available at any one time to fight the fire.

It has been reported that the entire interior of the store was a raging mass of flames for about three hours. The severity and exact duration of the fire before the collapse of the monowing T's forming the roof deck in ten out of one hundred bays, Fig. 1, are not known to the writers. Failure occurred in six bays (Area A) of the furniture and rug departments where the fire started, in two bays (Area B) that housed the paint department, and in two bays (Area C) in the food section.

There is a strong possibility that an accumulation of gases from the gas heating units caused explosions in Areas A and C. It further appears that flammable materials such as turpentine exploded in Area B. These explosions may have caused the displacements of the concrete-block curtain and partition walls and the collapse of the monowing T's in these areas.

Building framing

The Bargain City structure is 750 ft long and 200 ft wide. The clear height from the top of the floor to the under side of the roof panels varies from 15.0 ft at line A (Fig. 1) to 13.0 ft at line E, except for a 50-ft by 270-ft entrance area, P-Q-R-S, where the clear height is about 29 ft.

The principal framing consists of three basic members:

1. Precast, prestressed roof panels commercially known as monowing T's 50 ft long and 5 ft wide (Fig. 2).
2. Precast, prestressed-concrete inverted T-girders 30 ft long (Fig. 3).
3. Precast, non-prestressed concrete columns 14 in. square (Fig. 4).

Precast, non-prestressed reinforced spandrel beams and wind struts complete the structural framing of the building. The components were assembled into the building framing by

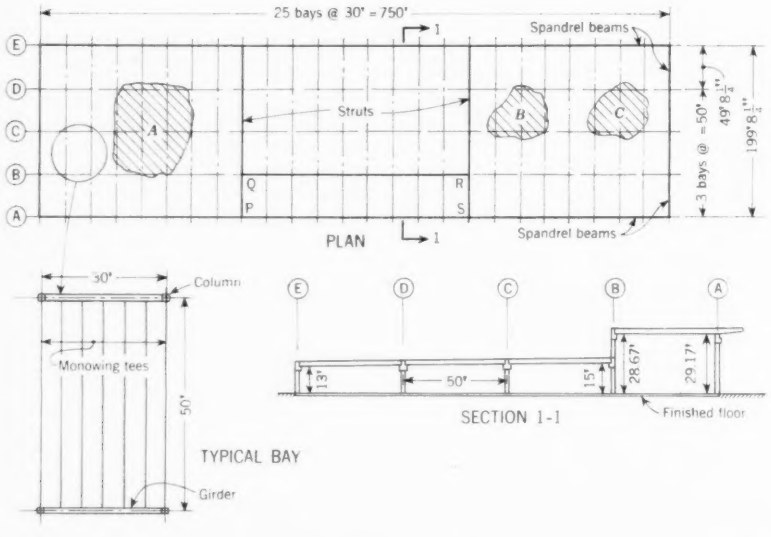


FIG. 1. Plan and framing of Bargain City, U.S.A., a department store that was subjected to a 5-hour fire.

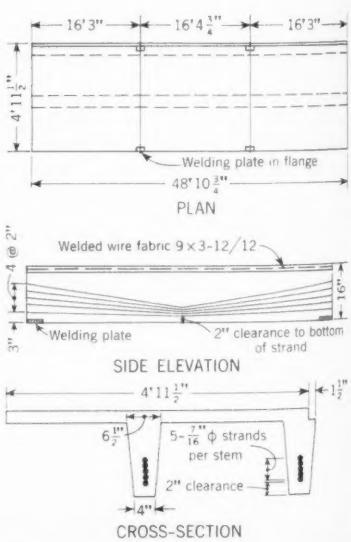


FIG. 2. Typical prestressed monowing T used for roof.

means of the typical connections that are shown in Fig. 5 to achieve the standard 30 x 50-ft bays. Six hundred monowing T's, 86 prestressed-concrete supporting girders, 130 precast columns and 64 precast, non-prestressed spandrels and struts were used in the 150,000-sq ft store area.

Consultants' assignment

On April 25, 1960, four months after the fire occurred, the firm of Schupack and Zollman was retained by the owners for the purpose of:

1. Surveying the damage caused by the fire.
2. Determining which structural members would have to be condemned.
3. Determining what structural members might safely be retained in the reconstruction of the building.
4. Developing methods of restoration.

A stipulation of this assignment was that engineering must be completed promptly so that all necessary restoration work and rebuilding could be finished in time for an August 15, 1960, reopening date. Since the actual repair work would be likely to require a considerable part of the total time available, a very short period actually remained for the engineers' investigation. This compelled the consultants to develop methods of investigation that would yield optimum results in the shortest possible time.

Girders whose adequacy could have been determined only by means of elaborate and time-consuming loading tests had to be discarded because of uncertainty as to the extent of the damage. Repairs were necessarily limited to instances of relatively minor structural damage and had to be completed expeditiously and at lower cost than the purchase of entirely new structural elements would entail. Replacements for discarded members were readily obtainable from producers of prestressed concrete in the area.

The task of determining which elements were damaged beyond repair, the extent of the damage in each individual case, and of estimating the magnitude of the repair work, began on April 27 and was completed on July 1. The following considerations developed on the basis of extensive laboratory fire tests on the effect of heat on prestressing steel and concrete carried out by other organizations (see bibliography) served as a guide for the engineers' investigation.

Effect of heat on prestressing steel

When exposed to heat, cold-drawn steel such as that used in strands for prestressed concrete work, is annealed with the result that the modulus of elasticity decreases by about 6 percent at 400 deg F and by about 20 percent at 600 deg F, which in turn results in the reduction of tension in the strands. Further reduction of tension occurs with a rise in temperature as a result of relaxation of the steel due to creep. The elongation of wires is not linearly proportional for temperatures above 300 deg F, and is not recoverable upon cooling. This would cause a further reduction of tension in the steel. Thus, when the steel in a loaded prestressed beam is heated to between 400 and 600 deg F, a reduction in camber or pronounced deflection can be expected.

It has been found further that after strands are heated to a temperature of 375 deg F, half that necessary to cause collapse, a beam will show an appreciable loss of prestress upon cooling. A marked *permanent* deflection will be present after removal of the imposed load, but the ultimate strength may still remain a high proportion of the original value. Collapse due to failure of the steel will be gradual, and will not occur until the temperature of a number of strands sufficient to cause such collapse reaches about 750 deg F. However, warning of imminent collapse is given by the development of a distinct sag, which generally will increase markedly before collapse.

Effect of heat on concrete

When concrete is exposed to heat, a progressive expansion of the aggregates will occur, while the cement, after a certain time, will shrink through loss of water. This shrinkage will exceed the expansion when the temperature has risen to about 600 deg F. Above this value the steady

Before and after fire damage. The top photo is of a similar structure rather than the one damaged by fire.

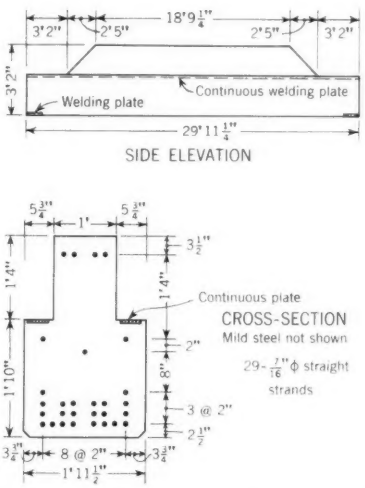


FIG 3. Typical prestressed inverted-T girder. Mild steel reinforcing is not shown.

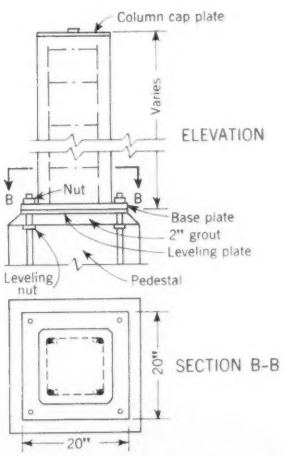


FIG. 4. Typical precast concrete column. These were not prestressed.

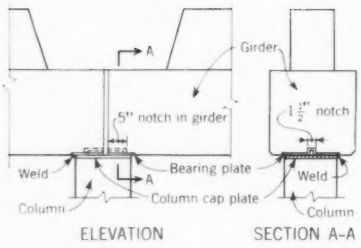


FIG. 5. Detail at top of column, showing girder connection.

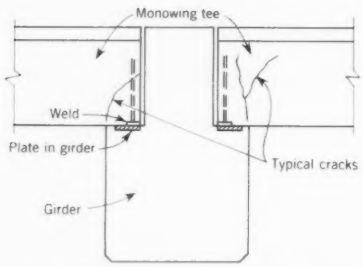


FIG. 6. Connection of monowing T to girder. Typical cracks, found primarily in areas of high fire intensity, have been added to sketch.

drying shrinkage of the member under sustained heat will first cause crazing of the concrete surfaces, and then will weaken and crack the concrete itself.

If natural stone is the coarse aggregate, the concrete will spall off. Such spalling will be pronounced if the equilibrium of the relative humidity of the member is high, as would be the case when a member is of relatively recent manufacture. The application of a hose stream on a heated concrete surface also causes crazing and spalling of the concrete.

In so far as strength is concerned, it has been established that the residual strength of heated concrete is further reduced upon cooling. A noticeable reduction in bond between the steel and the concrete can take place when temperatures reach the range of 600 deg F. It should be brought out, however, that in large members, the temperature varies throughout the thickness of the beam subjected to heat. Although the surface layers may be at 1,100 deg F or more, the temperature of the inside concrete may still be comparatively low. Discoloration of the concrete from its natural gray to white bears a very close relation to variation in temperature from normal to high. Surface smoke discoloration, as indicated by the presence of soot, can occur at relatively normal temperatures.

Resulting effects on bearings

A pronounced sag in a concrete beam will probably be accompanied by distress at the bearings, in the event that the steel connections have to some degree achieved end restraint. Rigid welded connections do not allow the beam to follow thermal movements, and the shortening that occurs during cooling can cause the appearance of cracks such as have been added to Fig. 6.

Methods of testing

The above considerations indicate that if a loss of camber has taken place, the implication is that the prestressing steel has lost some of its tension and the member must have been exposed either to high temperatures or to a sustained heat of somewhat lower intensity. For this to have occurred, however, the concrete itself must have been visibly damaged by the heat, and this of course should be revealed by visual inspection. At the same time restraining supports should be examined for signs of distress. It follows that the procedure to be adopted for the investigation of each member in a structure should be:

1. To determine elevations of members with a surveyor's level. Camber loss can be determined by comparing measured elevations with those of undamaged members or with the computed camber.

2. To confirm this finding with visual inspection for crazing, cracking, spalling and discoloration. This visual inspection is to be supplemented by soundings to determine concrete quality. A test hammer such as the Schmidt hammer, for immediate non-destructive determination of the compressive strength of the concrete, as well as the chisel end of a mason's hammer for chipping the concrete, should be used for this purpose.

3. To check the conditions at the bearings for evidence of distress.

4. To estimate the intensity and duration of the fire on the basis of the condition of metal boxes, wooden frames and various hardware in the vicinity of the member under study.

Investigation of monowing T's

Proceeding on the basis outlined above, it was determined that the presence of one, or a combination of several, of the physical findings given below would be sufficient cause for condemnation of a member. These characteristics would be:

1. Total disappearance of original camber
2. Presence of sag
3. Cracking or spalling along the bottom of the stems parallel to the strands (see Fig. 7)
4. Severe concrete cracking at the bearings

It was rather consistently found that in cases where monowing T's had lost all of their camber, Schmidt hammer readings on the stems ranged from low values at the bottom to high values near the juncture of stem and deck slab. At the bearings, cracks in the concrete starting at the welded connections, and opposite in direction to normal shear cracks, were observed in most of those monowings that had lost all their camber. Concrete discoloration confirmed the assumption that these particular monowings had been subjected to intense fire. Such members initially gave the *appearance* of being sound except for their sag. However, it was necessary only to hit the concrete with the chisel end of a mason's hammer, removing chunks of concrete up to the level of the bunched strands, to determine the extent of the actual damage, as seen in Fig. 7. The condemned monowings were limited primarily to areas where the fire had been most intense.

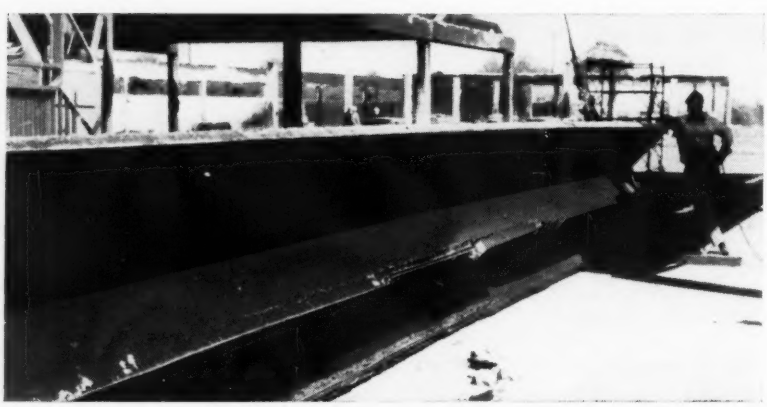


FIG. 7. Monowing T from area of high fire intensity. Note exposed prestressing strands at the bottom of the T.

TABLE I. Deflection of monowing T's under 60-psf test load

	Half Load 1 hr.	Full Load 1½ hr.	Full Load 22 hr.	Full Load 91 hr.	Unloaded 2 hr.	Unloaded 20 hr.
T No. 315:						
1	0.19	0.31	0.41	0.53	0.01	0.02*
2	0.10	0.24	0.29	0.43	0.02	0.01*
3	0.25	0.39	0.49	0.64	0.05*	0.09*
4	0.12	0.26	0.37	0.52	0.09*	0.16*
5	0.25	0.29	0.34	0.42	0.05*	0.09*
6	0.14	0.16	0.19	0.31	0.12*	0.13*
T No. 322:						
7	0.14	0.35	0.43	0.52	0.05	0.02
8	0.12	0.27	0.33	0.48	0.08	0.05
9	0.17	0.42	0.53	0.65	0.03	0.01*
10	0.14	0.29	0.38	0.48	0.04*	0.08*
11	0.11	0.25	0.33	0.39	0.01*	0.05*
12	0.07	0.13	0.19	0.24	0.08*	0.11*

* Indicates "recovery" to above the original position.

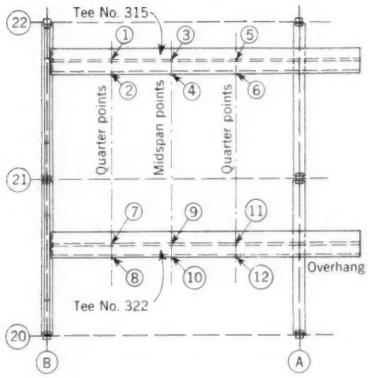


FIG. 8. Layout for test of monowing T's. This "in-place" test was made at side of building where T's overhang to form canopy.

Monowing T's that had retained their camber and whose appearance indicated that they had not been damaged by the fire even though minor spalling had taken place, were considered as structurally sound, or reusable if repaired. In these monowings, only hair cracks that would not endanger the load carrying capacity of the member were found. Schmidt hammer readings on the stems of such monowing T's were rather consistently high, thus confirming the high quality of the concrete and justifying their acceptability for re-use.

Monowing T's that could be classified as acceptable for re-use except for what was deemed an excessive loss in camber, as determined by level measurements, were placed in a doubtful category and scheduled for field load testing. Schmidt hammer readings of these T's were consistently high and the additional mason's hammer soundings confirmed that the high quality of the concrete was unimpaired.

Load test of monowing T's

To determine the structural adequacy of roof monowings that did not meet all the requirements governing their acceptance for structural use in the reconstructed building, a load test was conducted. The test procedure followed meets the requirements set forth in Articles 202 and 203 of American Concrete Institute Publication 318-56, "Building Code Requirements for Reinforced Concrete."

Two monowing panels were selected to be tested in place. Of the panels placed in the doubtful category, these two appeared the least likely to meet the rigid test requirements for stiffness and strength, and would thus provide the smallest factor of safety against failure. If these proved acceptable, the other panels listed in the doubtful category would also be acceptable.

The general testing arrangement is shown in Figs. 8 and 9. The welds connecting the panels being tested to their adjacent panels were cut before the test. In accordance with the provisions of ACI 318-56, the test panels were subjected to twice the design live load, or a total of 60 psf, since the superimposed dead load of insulation and roofing had remained on the panels.

In accordance with the requirements in Section 203 (*b*) of ACI 318-56, "a roof construction shall be considered to conform to the load test requirements if there is no evidence of failure and the maximum deflection does not exceed:

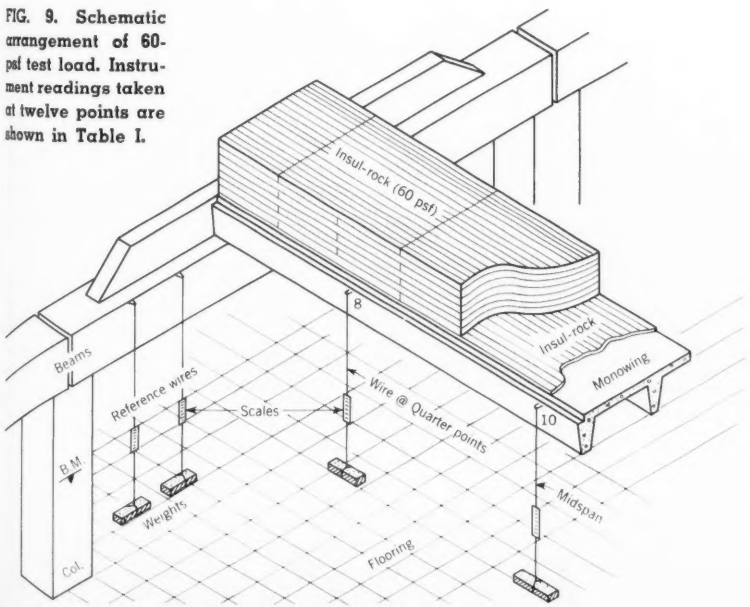


FIG. 9. Schematic arrangement of 60-psf test load. Instrument readings taken at twelve points are shown in Table I.

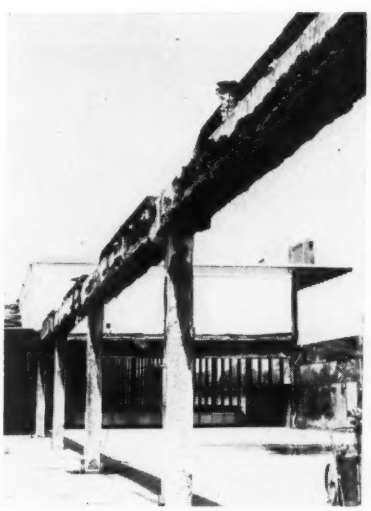


FIG. 10. Damage to supporting girder in paint area, where the most intense heat apparently developed.

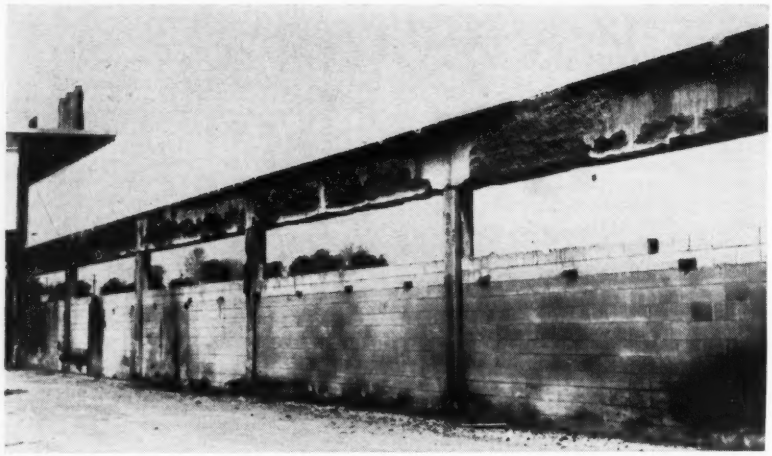


FIG. 11. Almost all the spandrel beams were found reusable. For appearance some repair was made on the concrete.

$$D = \frac{L^2}{12{,}000 \times t}$$

In this case, $L = 49$ ft or 588 in.
and $t = 16$ in.

Therefore $$D = \frac{588^2}{12{,}000 \times 16} = 1.8 \text{ in.}$$

The maximum deflection as read by instrument under full load was about ¾ in., substantially less than the permissible 1.8 in. computed above. In addition, since the actual deflection values were smaller than the computed theoretical deflections, it can be concluded that the behavior of the monowings under load was normal and such as can be expected of similar panels that have not been subjected to fire. There was not the slightest indication of distress in the monowings at any time during the test period.

The test load of 60 psf was actually exceeded, as heavy rains are estimated to have added at least 10 percent to the load because of the water-absorbing capacity of the "Insul-Rock." The test load on the panels was left in position for about 90 hours, substantially in excess of the 24-hour requirement.

Complete recovery of the deflections after removal of the load is an indication that the prestressing forces in the panels being tested were not adversely affected by the fire. In view of these findings, it was recommended that the panels in the doubtful category be used in the reconstructed building, provided necessary incidental repairs were made.

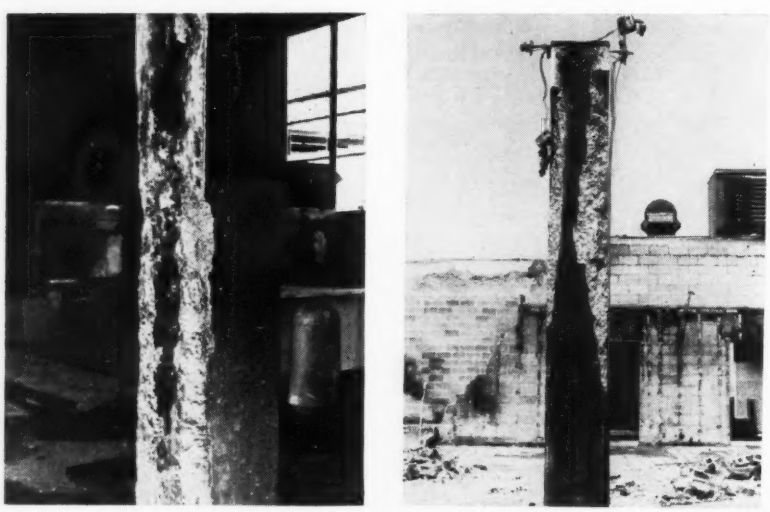


FIG. 12. Spalled concrete on one side of columns only indicates that major damage was caused by sudden cooling by water from fire hose.

Prestressed supporting girders

The extent of the damage sustained by the prestressed concrete supporting girders, without collapse, in areas of the most intense heat can be seen in Fig. 10. Since in heavy members the temperature varies throughout the section, the fire resistance is relatively higher than in the light sections of the monowing T's.

The criteria for acceptance of any particular prestressed concrete supporting girder were made very severe because of the importance of these girders in the structural framing. Any girder that did not show a residual camber, whose concrete was determined unsound through Schmidt hammer readings, or that had cracks at the bearings, was condemned. On the other hand, those girders that met all criteria except for surface crazing and limited spalling were accepted, subject to repair.

The appearance of the spandrel beams which were subjected to the most intense fire is shown in Fig. 11. It was found, however, that in spite of the poor appearance of the beams, their actual deflection readings were in agreement with the computed values. Careful visual inspection, Schmidt hammer readings, mason's hammer soundings, and observance of spalling —which extended very little beyond the reinforcing steel—were the determining criteria for the acceptance of a beam. Almost all the spandrel beams were found structurally sound, but for the sake of appearance were scheduled for at least some degree of repair.

Precast concrete columns

Of the heavy members, the columns appeared to have suffered most. The fact that in many cases only one face of a column was severely damaged, as indicated by crazing, discoloration, cracking and spalling (Fig. 12), and that the original paint still remained on the other three faces, pointed to the hose stream as the principal cause of the surface damage.

It was frequently found that excessive spalling had taken place at the corners of the columns. The vertical reinforcing steel was visible in some areas. This apparently had little effect on the structurally important core of the columns. Because of the relatively low cost of replacing a column, severely spalled columns were scheduled for replacement without extensive investigation. However, wherever the removal of a column would require the removal of additional sound superstructure elements, thorough investi-

gation was made to determine possible methods of repair. In a few such instances, extensive restoration work was recommended.

Restoration procedures

Several methods of repair were considered by the consulting engineers. It was recommended that all loose concrete be removed with an air hammer until the surface of the sound concrete was reached. Wire mesh was then to be provided around the damaged area, and mortar, applied by pneumatic methods, used to restore the original dimensions of the member.

Comments made by the experienced workmen doing the restoration work were that after removal of the loose concrete the condition of the remaining concrete was remarkably good. This tends to confirm the conclusion reached during the investigation that even though the appearance of a member was outwardly very poor, such a member might still be entirely sound from a structural point of view. The partial loss of, say, 1 to 3 percent of the strands in a member represented a negligible reduction in its ultimate load-carrying capacity.

Conclusions favor prestressed concrete

1. In a 150,000-sq ft building, with neither fire walls nor sprinkler system, and containing highly combustible merchandise, a fire of high intensity raged uncontrolled for 5 hours. That so much of the structure remained standing and could be restored is a remarkable tribute to prestressed concrete as a construction material.

2. Even though the outward appearance of supporting girders, beams and columns in many cases was very poor, appearances proved deceiving. After careful inspection such members were found in a great many instances to be structurally sound. On the other hand monowing T's, in the area of intense fire, the appearance of which was generally good, proved to be structurally inadequate on closer inspection. After the restoration of damaged members, it was impossible to detect a difference between the restored and the untouched members.

3. It is surprising that no shear cracks of any kind were to be found in monowing T's with pronounced sag. Since they had lost much of their prestress, this type of crack would normally be expected. Further study of "shear" in members subjected to fire would therefore seem to be called for, inasmuch as current thinking is that stirrups are required to avoid excessive spalling. Based on observations made during this investigation, it would seem that the lack of stirrups in thin members would not cause any structural problems.

4. The task of judging fire damage as well as the further usefulness of concrete building components that have survived exposure to fire revealed a need for a reliable basis for such evaluations.

5. Fire research laboratories should establish the significance of fire-induced cracks in the critical zones of load-carrying members.

6. There is a need for more detailed knowledge of the effect on concrete of exposure to fires of less intensity but of longer duration than those outlined in the American Society for Testing Materials Designation E-119.

7. As a result of the patterns and consequences of this as well as other fires, the question arises whether the fire tests, as presently outlined in the ASTM Specifications, might require modification so that they would more closely approximate actual fire behavior.

8. The criteria for salvage of fire-damaged prestressed-concrete flexural members, where only a small percentage of the total number of strands appear to have been exposed to fire as indicated by spalling, and the manner of restoration of such members to their original condition of prestress, should be the subject of further study.

9. Apparently damaged structural concrete members should not have to be removed because of uncertainty as to the extent and significance of the damage caused by fire. Some study directed to the purpose of giving structural concrete members a "second chance" after one fire exposure appears necessary.

10. The effect of partial restraint at supports caused by welded connections in prestressed concrete members in general, and particularly those subjected to fire, should be further studied and evaluated.

11. In the evaluation of structural materials, fire retardant tests serve as the basis for fire-resistance ratings and express fire retardance in terms of hours. To obtain a fire-retardant rating, a structure subjected to a fire test must:

a) Sustain its design load during the specified period without collapse.

b) Prevent the passage of flame or hot gases from one area to another.

c) Be capable in many instances of sustaining twice its design load after the conclusion of the fire test.

d) Avoid a temperature increase on the unexposed surface in excess of 250 deg F.

e) In addition, under the conditions of acceptance, the sample may be subjected to a hose stream test of specified intensity and duration immediately after the fire test. The sample must withstand the impact, erosion and cooling effects of the hose stream without penetration or collapse.

The term "fire-resistive" has a very definite and sometimes statutory meaning in terms of a two- or three-hour fire-retardant rating. Therefore the intensity and above-average duration of this particular fire, plus the findings as presented here (that is, exposure to intense heat for an extended period of time, the satisfactory load tests under twice the design load, the application of the hose stream) would serve to indicate that the structure investigated would have received a fire-retardant rating more than adequate to meet the requirements of local, state or federal building codes.

The question is frequently raised as to whether prestressed concrete framing is "fireproof" construction. Actually, the amount of punishment withstood, without collapse, by prestressed concrete members in areas of intense heat, as described here, has been a revelation to the investigators. On the other hand, severe fire damage was noted in metal appurtenances, as indicated by buckling of steel doors, distortion and twisting of control boxes, ventilation housings, and heating pipes.

The investigation described was carried out by Aviv Rubin and Marcello G. Garavaglia, engineers on the staff of Schupack and Zollman, under the supervision of Charles C. Zollman, F. ASCE, partner. They wish to acknowledge the close cooperation received from Prestressed Structures, Inc., Frank Olevsky, president, who were the builders of the structure investigated, as well as that of the Eastern Gunite Company, Bala Cynwyd, Pa., with Philip Heaver, president, who did the repair and restoration work.

They are also indebted to C. C. Carlson, manager, Fire Research Section, Research and Development Laboratories, Portland Cement Association, Skokie, Ill., for his valuable comments and a number of photographs used in this report, as well as to A. H. Gustaferro, of the Portland Cement Association's Structural and Railways Bureau, for review and comments.

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Agitator discharges to tunnel invert from concreting bridge that rides on track set on the curb.

Finishers, riding on a rolling bridge, wood-float the surface of the invert.

Concreting the West Delaware Tunnel

GAIL KNIGHT, Assistant Chief Engineer, West Delaware Tunnel Constructors, New York, N. Y.

The last of the major tunneling work on New York's Delaware Water System was completed in September when the lining was finished on the West Delaware Tunnel. See Fig. 1. Excavation from five shafts and two portals was successfully holed through last January on 39 miles of bore with an excavated diameter of 13 ft 4 in. West Delaware Tunnel Constructors had been on the project for four years. The 39-mile length of tunnel was lined by working from four plant setups at shafts along the line and at the outlet portal. Concrete was dropped as far as 800 ft and was hauled a maximum of 37,000 ft in the tunnel.

While this article is on lining, a brief comment on excavation is of interest. A world record for tunnel advance was set in 1958, an average of 83 ft a day being attained for six consecutive days (this has since been exceeded elsewhere). Drilling was done from a two-level jumbo, moved on tracks of 30-in. gage. Experimentally, small 2-in. burn holes near the center were drilled, then two 5-in. holes were tried, and finally a single 8-in. burn hole was drilled with a Gardner-Denver No. 143 screw-feed drill. About 42 holes of 1¾-in. diameter were drilled with carbide-tipped bits and loaded with 5.7 lb per cu yd of semi-gelatin dynamite and up to No. 9 Hercules No Vent delay caps. The average advance was 11 ft per round. Mucking was done with an Eimco No. 40H loader delivering to Pressed Steel Car Co. side-dump cars of 5-cu yd capacity. These were hauled up to 7 miles to shafts by Plymouth 10-ton and 15-

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EDITOR'S NOTE: The concrete lining has been completed on the 44-mile West Delaware Tunnel of New York's Delaware Water Supply system. Four of five large contracts, totaling about $80 million, for tunneling and lining, were held by a joint venture of Johnson, Drake & Piper, Inc., Winston Bros. Company, Tecon Corporation, The Conduit & Foundation Corporation and, for the first two only of the four contracts, the Grafe-Callahan Construction Company. On all four of these contracts Johnson, Drake & Piper, Inc., was the managing firm, with Howard Dixon, F. ASCE, vice president, in charge. Clancy O'Dell was project manager, R. P. King, chief engineer, and Gail Knight, assistant chief engineer. John Hester was general superintendent.

The first two of the contracts were completed six months ahead of the required schedule, and the second two, 14 months ahead. On completion of the work in September of this year, Stanley Dore, F. ASCE, chief engineer of the New York City Board of Water Supply, wrote the contractors as follows:

"This letter takes occasion to compliment your firm upon the excellence and competence with which the entire conduct of this work was progressed, including not only the satisfactory driving and lining of shafts and tunnel in accordance with the Board's plans and specifications but also interested and meticulous consideration of safety provisions, pleasant labor relations, agreeable relations with the communities in which this work was done and particularly, from my point of view, frank and whole-hearted cooperation with the Board of Water Supply and its engineers and the Comptroller's office in the construction of these large contracts to the City's satisfaction. Temporary and minor disagreements were readily resolved and lasting disagreements nonexistent."

On the $35.6 million bid for the first two contracts, the joint venturers were about $7 million below the next bidder. Each of the firms had estimated the cost independently and felt that it was "right." They had an added incentive to make it a financially successful project—and it was. Unusually good planning, no skimping on equipment, and the establishment of the best of labor relations from the start—with a bonus "all the way down the line" for high production—were major factors in the success of the project.

Conveyor, with 45-deg troughing rollers, raises concrete to hopper over pneumatic placer.

Concrete is blown through 140-ft line along tunnel crown and compacted against the rock.

ton diesel locomotives. Water scrubbers cleaned the diesel exhaust to keep down undesirable fumes in the tunnel.

Haul was limiting factor

Selection of equipment for lining the tunnel was based on the amount of concrete that could be hauled on the single-track railroad within the allowable mixing-to-placing time specified by the Board of Water Supply. From the quantity of concrete that could be moved it was a simple matter to determine the length of arch forms needed and the size and location of the batch plants.

Mixing on the surface and hauling of the wet concrete in the tunnel follows the practice previously used on more than 100 miles of Delaware Aqueduct constructed for the New York Board of Water Supply since 1939. The tunnel has a lined diameter of 11 ft 4 in. with an "A" line (minimum permissible excavation) of 12 ft 4 in. in diameter. Agitator equipment for hauling the concrete was mandatory to correct any segregation of materials that might occur from the long haul as well as to provide rapid discharge to the placing equipment. The largest agitators that could pass in the unlined tunnel had a capacity of 4 cu yd. A maximum of 450 cu yd of concrete per shift could be delivered from one shaft by the diesel locomotives used earlier for excavation. Other equipment was designed to meet this production rate.

Two concrete plants were used, set up successively at Shafts 1, 3, 5 and 6 and at the outlet portal (Fig. 1). The aggregate handling facilities at each location were planned to handle 1,800 cu yd of material per day. The long winters, with snow storms and cold weather, required a stock pile of aggregate for concrete operations between November and May. The system selected as the most economical was to build steep-sided embankments with tunnel muck. Trucks bringing in aggregate from the supplier drove up a ramp onto the muck pile and dumped their loads from the top, eliminating handling equipment. The materials were reclaimed as required by a 2¾-cu yd Michigan rubber-tired front-end loader into a 10-wheel F-800 Ford rear-dump truck. The truck then drove up a ramp, turned and backed onto a bridge to the top of the batch plant, where the loads were dumped into the desired compartment. Cement was trucked directly from the mill to the batch plant.

Both concrete plants were C. S. Johnson units, designed to hold 200 cu yd of aggregate and 300 bbl of cement. Aggregates were batched manually in a concentric hopper; separate batchers handled cement and water. Batches were chuted alternately into either of two 2-cu yd Koehring 56S non-tilting mixers. One cubic yard of concrete for lining was made up of: sand, 1,034 lb; ¾-in. gravel, 803 lb; 1½-in. gravel, 1,208 lb; and 2 bbl of cement. The cement was made to a special specification of the New York Board of Water Supply.

The 2-cu yd batch of concrete was dumped into a collecting hopper over a 10-in. double-strength steel drop-pipe located at the edge of the shaft. The drop lines were plumbed within ⅛ in. because the concrete falling at a high velocity quickly wore through any pipes that were out of plumb. The drop-lines varied in length from 400 ft to 800 ft depending on the depth of the shaft. U-bolts, at 20-ft intervals, held the pipe to the shaft steel, and clips welded to the pipe supported the weight of pipe and concrete.

At the top of the tunnel the concrete was discharged into a steel box called a "boot." The boot was roughly square in shape, 30 in. on a side and 6 ft deep, with an outer frame of mild steel 1 in. thick. A 1-in. liner of abrasion-resisting steel covered the inside and a stack of 1-in. plates filled the bottom one foot of depth. One side had an overflow opening a foot from the top of the boot so that a cushion of concrete was provided for the falling concrete. The concrete flowed from the opening in the boot down an enclosed chute to a closed hopper of 2-cu yd capacity. The velocity of the concrete as it fell in the pipe was partially controlled by self-generated air pressure regulated by an air opening 4 in. in diameter in the top of the otherwise closed hopper.

The hopper was located over a rail siding where the 4-cu yd concrete-agitator cars could be loaded through an air-operated swivel gate. The loading and batching operation was controlled

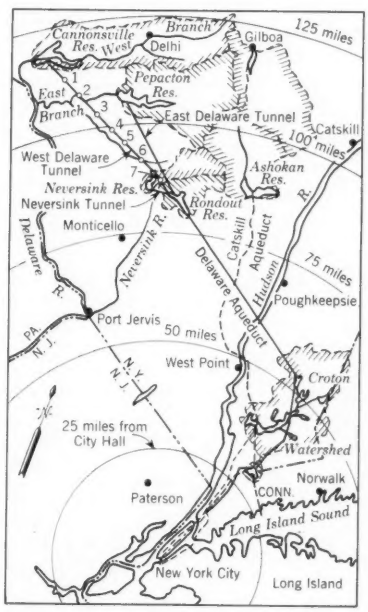


FIG. 1. Concreting has been completed on the West Delaware Tunnel of the New York City Water Supply. Concrete was mixed at Shafts 1, 3, 5 and 6, and at the outlet portal.

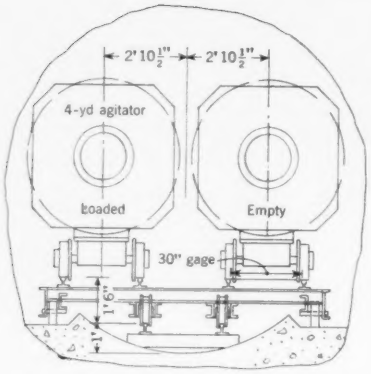


FIG. 2. Equipment for concrete placing was based on the maximum size of agitator cars that could pass in the tunnel.

by a gate operator who had direct verbal communication with the batch plant.

The 4-cu yd Jaeger agitators used were electric powered units with forward and reversing switches and were coupled in trains with Joy electric plugs. They were mounted on 10-ton flat-cars of 30-in. gage, manufactured by the Pressed Steel Car Company. Cars were coupled into trains with Can't-Miss couplers and hauled by the 10-ton Plymouth diesel locomotives used in tunnel excavation. The number of agitators these locomotives could haul was controlled by the grades but in general varied from 4 to 8, with 6 as the average number.

Clean-up and curb

Concreting covered four related operations: curb, invert, arch, and grouting. The curb concreting operation on the first 102,000 ft (19.4 miles) of tunnel was done as a separate operation after tunnel excavation was completed. One crew used an air blow-pipe, and an Eimco 40H mucking machine to clean the tunnel bottom. A second crew set the curb forms on three shifts and poured concrete on one shift. The curb forms were placed on each side of the single-track railroad and positioned with turnbuckles.

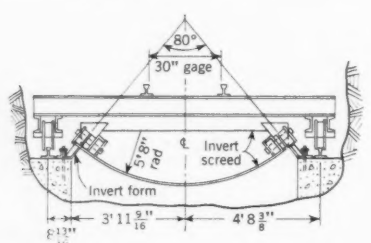


FIG. 3. Small forms were bolted to the previously placed curb to permit placing 80 deg of arc in the invert.

Any unevenness in the rock under the form was filled in with bags of sand.

The curb concreting on the second 102,000 ft of tunnel was done simultaneously with tunnel excavation operations. No cleaning or concreting equipment could be on the track, which had to be open for the hauling of tunnel excavation. These conditions made it necessary to clean the muck from the curb area on Saturday. (A five-day work week was generally followed.) Enough curb could be cleaned on three shifts on Saturday to keep the concreting crews busy during the five day week.

The independent curb concreting operation progressed about 600 ft on a three-shift day. This operation, in conjunction with excavation, totaled about 125 ft per day, paced by the excavation. The simultaneous operation cost about the same in direct labor but the smaller quantity of concrete made the unit batching cost greater. The big advantage of this method was the saving in over-all time. This was not to meet a schedule but to terminate overhead at the job site at an earlier time.

In line with Board of Water Supply specifications, the area under the curb and invert was cleaned very carefully and completely. Air blow-pipes and brooms removed all debris to assure a tight bond of concrete to the rock. Concrete was chuted direct from the agitators into the curb form. The invert area between the curbs was next cleaned using blow-pipes, a small dozer, an Eimco 40 mucking machine and muck cans. The invert clean-up removed the track, the ties being removed and the individual rails placed on top of the curbs.

The equipment for concreting the invert consists of a ramp, a rail-changing bridge, a concrete-placing platform, a screed, and the necessary air hoists. All this equipment is fastened together as a unit and, with the exception of the ramp, rides on the rail mounted on the curb. See Fig. 3.

Concreting the Invert

Placing of the invert concrete started at the shaft and worked away from it. As the concrete advanced the rail was taken from the curb and spiked to beveled ties on the invert. The rail was held in line with a clamp for each 30-ft rail section. The clamp was required as there was no ballast to keep the track from shifting. Passing sidings (California switches), mounted on wheels for moving, were installed for each 10,000 ft of advance. These sidings served both for the invert concreting and the arch concreting operations.

A loaded train for invert concreting climbed the 3-percent grade of the ramp, then passed over the rail-changing bridge to the invert concreting bridge. The rail-changing bridge was 40 ft long with space below for the workmen to remove the rail from the curb and spike it to the invert ties. The invert concreting bridge was a work platform 1,000 ft long mounted on double-flanged wheels. It supported the concrete trains over the fresh concrete and allowed working room under the trains for the concrete screed and platforms from which the finishers could work. The bridge rode on 60-lb rail; it rested, unanchored, on the concrete curb.

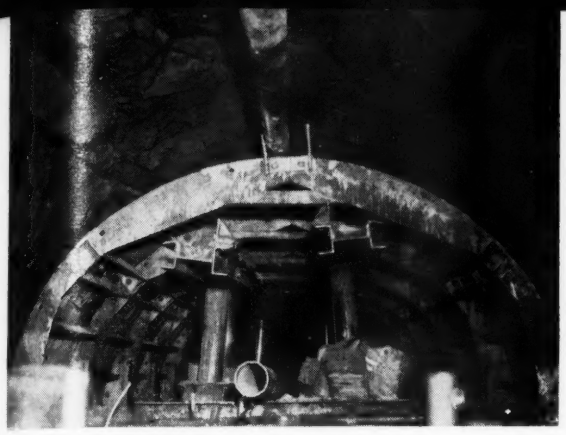
The bridge unit was moved by a geared Joy air-hoist of the turbine type mounted on the forward end of the bridge. Adjacent to this hoist was a second unit used to pull the concrete screed. The screed was shaped to the radius of the invert and rode on forms 6 in. high, which were bolted to the curb.

When the concrete trains reached the required position on the bridge, the electric motors of the agitators were plugged into sockets, available at intervals along the 1,000-ft length of the bridge. Concrete was remixed and then discharged in front of the screed by rotation of the drum. Finishers followed behind the screed, riding on platforms rolling on the invert forms, using short wooden floats to hand-finish the concrete. Richmond screw anchors of 1¼-in. diameter were placed at 40-in. intervals to hold the arch forms and to anchor the track in position when it was set on the invert.

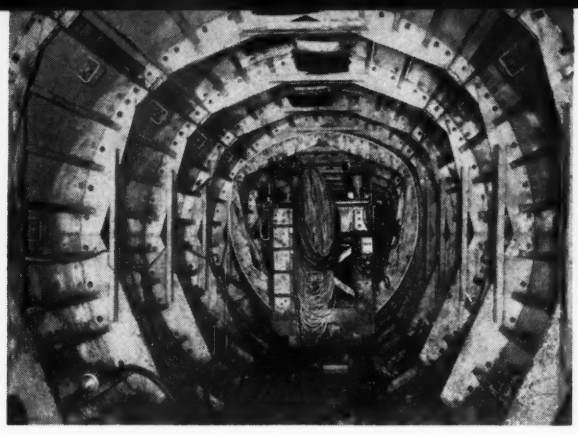
The 80-deg arc of the invert concrete was selected to allow telescoping of the arch forms (Fig. 3). Considerable finishing labor would have been saved if the arc of the invert had been about 70 deg. It was difficult to hold concrete up to the invert forms, as a consistent slump could not be maintained because the haul time for the trains varied. Slump variation was more noticeable on the longer hauls, which ranged up to 30,000 and even 37,000 ft.

The operation of concreting the invert was unchanged throughout the 208,000 ft of tunnel. Average progress was about 1,000 ft per working day although this varied with the amount of concrete placed, the experience of the crews and the interference of other operations.

Concreting of the arch started at a different distance from the shaft at each plant location and worked towards the shaft opening, the longest haul again being 37,000 ft. Track and switches from the invert concreting



Arch form is being raised to position by hydraulic jacks in the form traveler. Note rock bolting of roof.



Hydraulic traveler carries telescoped form (outlined in white) through arch forms ready for concrete.

operation were again used on the arch.

Added equipment for this arch concreting included a long movable switch platform. A ramp at the end toward the shaft led up from the main-line track to the wider area needed for the agitator cars to pass. An additional incline was provided for pulling the agitator cars as high as possible to discharge on to a concrete conveyor. See Fig. 4. The 30-in. belt conveyor, on 45-deg troughing rollers, and powered by a Gardner-Denver air motor, elevated the concrete into a 3-cu yd hopper mounted over a Pressweld concrete placer of 1⅛-cu yd capacity. The placer used compressed air to force the concrete into the top of the arch forms through 40 ft of 6-in. "slick" pipe (with smooth joints inside and out).

A 6-in. pipe from air compressors on the surface supplied air for a Pressweld blower. For maximum efficiency, the blower required 3,000 cfm of compressed air. To meet this high momentary demand an air receiver 54 in. in diameter and 20 ft long was mounted adjacent to the blower to supplement line delivery. The complete arch pouring assembly was moved by a Joy Turbo Air car-puller mounted on the leading end of the platform.

The arch forms were of telescopic type designed to be moved through forms in use. They were handled in 30-ft units by a completely hydraulically operated form carrier. A total of 450 lin ft of arch forms was provided at each setup. The concrete in a circular tunnel becomes self-supporting by its arch action after a few hours, and then the forms can be stripped. Use of 450 ft of form allowed time for the concrete to reach adequate strength before the forms were loosened, telescoped, and moved to the front. Grout pipes, with couplings against the form and an open end in contact with the rock, were placed through holes in the arch form.

The grouting operation was carried out in two stages. Low-pressure grouting could start 15 days after the arch concrete was placed. The second-stage, high-pressure grouting could start 30 days after the arch concrete was completed. A C.H. & E. air-powered mortar mixer was used with a Gardner-Denver air-powered reciprocating grout pump. The latter had interchangeable cylinder liners to vary the pressure of the grout.

Low-pressure grout was first pumped to refusal through hose connections to the pipes set in the arch concrete. From 0.03 to 0.05 cu yd of a mix of neat cement and 7 to 10 gal of water per bag of cement were injected per lineal foot of tunnel. The rail-mounted grouting outfit then moved to the next grout hole.

In some areas heavy flows of water were encountered and supplementary high-pressure grouting was required. This was done after the first grout had hardened. The operation was started by drilling the grout out of the pipes with a stoper before attaching the high-pressure grout hose to the coupling. From 0.02 to 0.05 cu yd of grout per lineal foot of tunnel was again forced in between the rock and the concrete. The mix consisted of 7 to 16 gal of water per bag of cement.

The grout fills voids between the rock and the concrete, especially any high overbreak in the arch. It also seals off water that might find its way through the rock or the concrete.

When Cannonsville Dam is completed and the reservoir filled, the West Delaware Tunnel can add 310 mgd of dependable flow to the water supply of New York City. The total of more than 1,800 mgd that will then be available from the mountainous area north and west of New York is expected to be adequate for the needs of the city for the rest of this century.

Construction of the West Delaware facilities is under the supervision of N. LeRoy Hammond, F. ASCE, deputy chief engineer, and Stanley M. Dore, F. ASCE, chief engineer of the Board of Water Supply, City of New York.

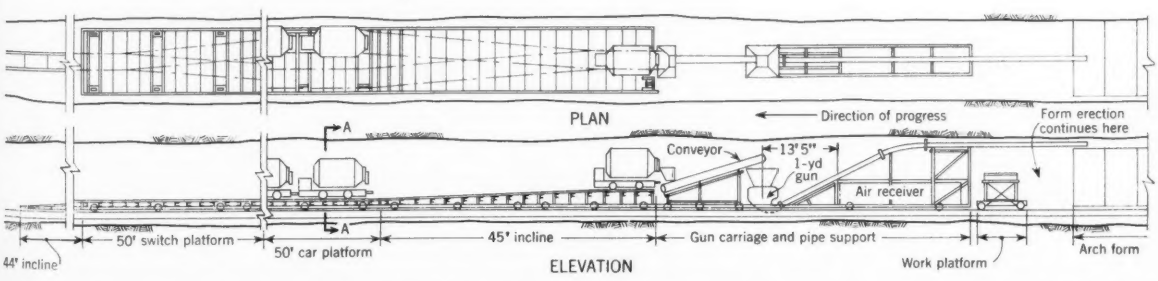


FIG. 4. In the arch concreting arrangement, loaded cars were pulled up the incline to discharge on to a concrete belt that fed the hopper over the pneumatic placer.

Girder holds up Des Moines Bank

L. A. PERDUE
Production Manager, Midwest Division
Pittsburgh-Des Moines Steel Company
Des Moines, Iowa

A big girder is holding up a bank —four floors and the roof—in approved Midwestern style at Des Moines, Iowa. This five-story addition to the Bankers Trust Company's old 12-story structure next door had to be built over a security vault, provide a banking floor without columns, and be so designed as to permit future removal of the adjacent 12-story structure.

The girder was lifted to roof level—by jacks used for lift-slab construction —and from it the floor beams were hung. By this means a columnless space 55 ft by 84 ft is provided on the four floors above the ground floor, and the ground floor is completely unobstructed for banking. The big member actually is a double plate girder 15 ft 9½ in. deep. It was fabricated and moved to the building site as two separate girders, each with an 1 1/16-in. by 15-ft web in the center, the web thickness increasing to ⅞ in. at the ends of the 84-ft-long unit. The top flange over each web is an 18½-in. billet 4½ in. thick (3½ in. at the ends). The bottom flange plate is 10 in. by 5 in., again decreasing to 3½ in. at the ends. Exterior web stiffeners are structural T's cut from 16 WF sections and used with the flange on the outside.

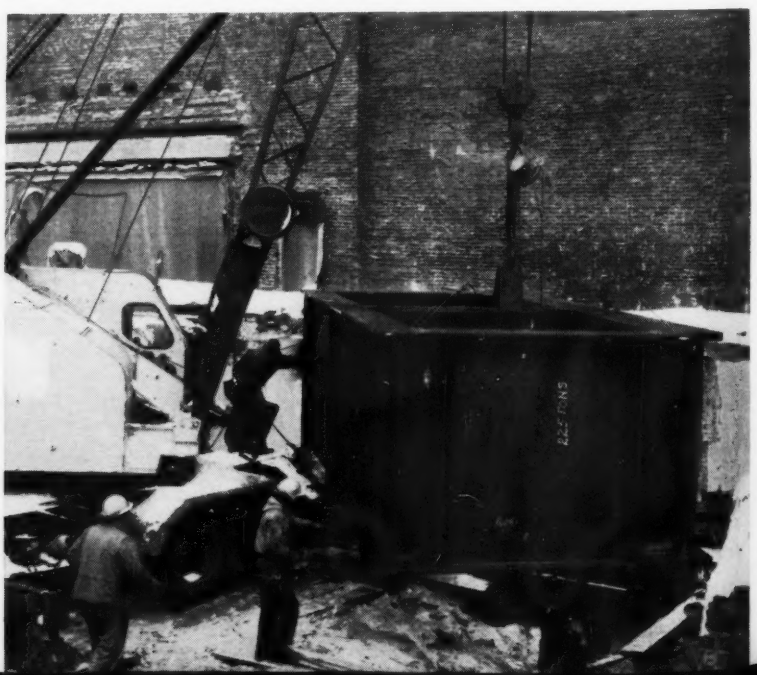
The two separate girders were assembled into a unit with the webs 1 ft 7½ in. apart and an 18 WF 50 between them to serve as a stiffener. The interior and exterior stiffeners are on 10-ft centers but offset from each other by 5 ft.

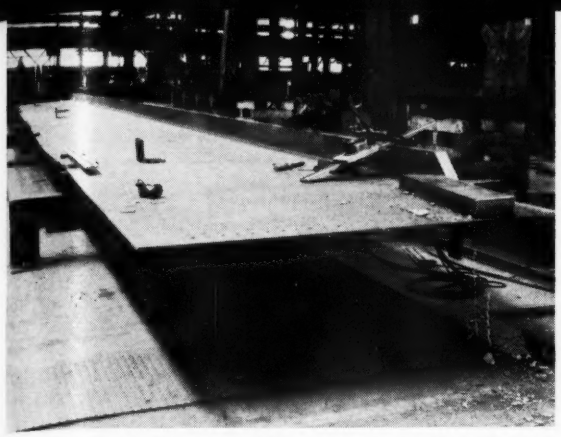
In the shop, the plate girder was first made up into two T-sections. Automatic welding was used to attach the flange plates to the web section. Preheating of the very thick flange plates was necessary to control warping. Assembly of the plate girder was accomplished by fitting the two T-sections together and automatically welding the horizontal web splice. The double girder was completely shop assembled with all holes reamed to insure proper fit and trouble-free assembly in the field.

The double girder was to be supported from two towers—the tower needed for the bank of three passenger elevators at one corner of the building and the tower for the freight elevator at the rear. The girder carries one end of the floor beams plus a 10-ft cantilever overhang. This overhang decreases the load on the opposite end of the floor beams so that the moderate-sized columns on spread footings can carry the load. This puts a concentrated load on the towers and their supports, however. The supports had to be adjacent to and below the existing vault and the foundation of the present 12-story building, which has thick bearing walls and dates from about 1890. Steel H-piles were specified under the towers.

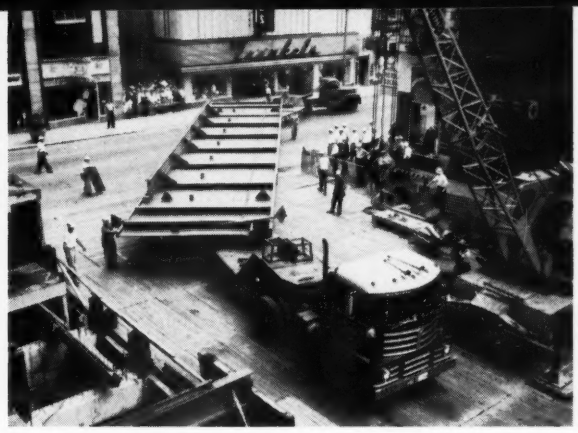
Deep-web steel sheetpiling, heavily braced, formed the cofferdam inside which the excavation and driving of the bearing piles was accomplished without undermining or damaging the existing structures. A heavy steel grillage, about 25 tons of box girder and

Nearly 25 tons of steel went into each of two grillages which form the walls of the elevator pits and distribute the heavy concentrated loads from the elevator towers and big girder to the pile cap and the piles below.





Web plate 90 in. wide was welded with automatic machines to one flange, then two T-sections were brought together to form half of the 15-ft-deep double girder.



Two low-boy trailers were required to transport each girder to the job site. A temporary beam stiffens what will be the lower edge of the girder.

base plates, was shop assembled and erected in one piece at each of the two major foundations. These grillages form the walls of the elevator pits and properly distribute the heavy concentrated loads to the pile cap and to the piles below. They also form a base for the steel towers for the elevators and the support for the double plate-girder.

The two units of the girder were transported separately from the fabricating plant some two miles to the erection site on two low-boy trailers.

Transportation of girder sections

It was necessary to plan the transportation of the two major girder sections to the job site with a great deal of care. It would have been ideal from an erection standpoint to haul the girders upright. However, their out-to-out height of 15 ft 10 in., plus the height of the truck bed and cribbing, would have made it impossible to get them—in this position—out of the shop or under the trolley wires in the area. Special bolsters on the trailers were necessary to permit the long girder to turn independently of the truck bed.

In turning, one truck-tractor pulled the lead unit while the second truck-tractor backed up. The overall distance from axle to axle of the tractors was 125 ft. The route to the job site was selected by the fabricator's traffic department, coordinated with the local transit company, and the details worked out with the traffic division of the Des Moines police.

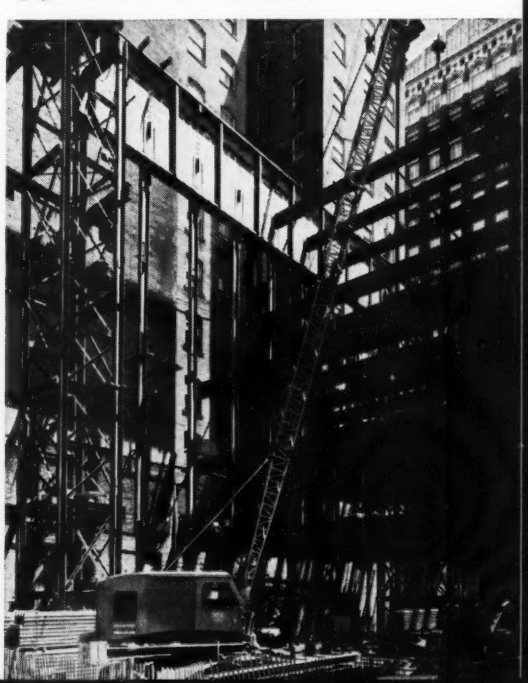
Because of the clearances involved in making the turns at some intersections, the first girder was transported to the job site during daylight hours. The time chosen was Sunday afternoon, when traffic in the downtown area was at a minimum. With the assistance of expert semi-trailer drivers, the first girder was off the street and in unloading position in 45 minutes after the start of the moving. The second girder was loaded in the shop three days later and followed the same route. The load left the plant at 3 a.m. and was off the street at the job site in 1 hour and 10 minutes.

Erection by subcontract

At the site the two girder sections were bolted together and prepared for the lifting operation, for which the Skyhook Lift Slab Corporation, of

To raise the girder, four jacks were set at the top of the main supporting columns at each end of the girder. Operations were controlled from one end to keep the big member exactly level while lifting.

Steel frame for five-story addition takes shape as floor beams are threaded through hangers from the big girder to form a 10-ft cantilever.



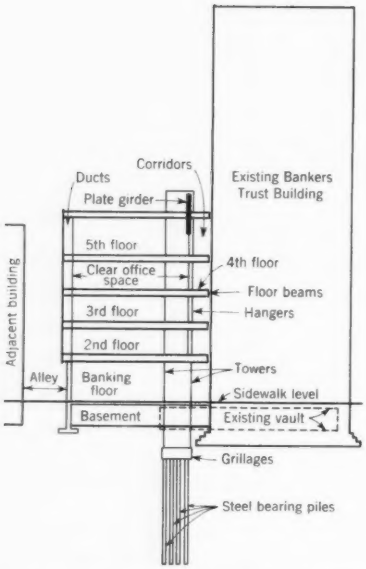


FIG. 1. Two pile foundations, set back from the old building, support the elevator towers and the big girder from which four floors of the new bank building are hung.

Kansas City, Mo., held a subcontract. Four hydraulic jacks of 50-ton capacity were set at the top of the main supporting columns at each end of the girder. Continuously threaded 1⅜-in. round rods were installed through specially prepared brackets on each girder and taken up as the hydraulic jacks lifted the girder.

As the girder was raised, the floor-level bracings and diagonal bracing at the elevator towers at the ends of the girder were installed. This provided adequate lateral bracing for the girder. Using this technique, erection proceeded without major difficulties. When the girder reached its final position, high-tensile-strength field bolts were used to permanently connect it to the two towers.

Seven hanger assemblies 55 ft long were connected to the girder by plates and angles to support the framing for floors two through five. The first floor is supported from below, and the roof beams frame into the girder. At the opposite side of the building, columns were erected to the second-floor level, where there is a set-out to provide duct space. Erection of 33 WF 130 and 36 WF 230 floor beams was done by crane for the full height of the building. The beams were threaded 10 ft through the hangers to cantilever out as far as the wall of the adjacent building. See Fig. 1. The floor beams are 10 ft apart and carry a cellular steel deck 4½ in. deep, which provides floor support.

The original design for this girder was a truss member using heavy 14-in. wide-flange column sections with horizontal webs for the top and bottom chords and with diagonals and verticals also composed of 14-in. wide-flange members. To take care of the secondary stresses, it was necessary to add cover plates to each flange of the top and bottom chords. To eliminate many of the fabrication problems of this type of truss, the fabricator recommended the double-plate girder.

Acknowledgments

The entire project illustrates what can be done when there is friendly coordination, cooperation, and planning among customer, architect, fabricator, erector, and local officials. The construction work was a joint venture of the Weitz Company, Inc., and Ringland-Johnson, Inc., both of Des Moines; James Kenworthy was the job superintendent. Steel was fabricated by the Pittsburgh-Des Moines Steel Company at its Des Moines plant. Superintendent for the Skyhook Lift Slab Corporation of Overland Park, Kans., was William Shull. Brooks-Borg, architects and engineers, did the architectural and structural design. John Rice was project architect, and John Hart and Charles Vanderlinden were the structural engineers.

Percentage fees for engineering services

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and **FREDERICK R. KNOOP, Jr., M. ASCE**
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Establishment of fees for professional civil engineering services is a frequent requirement which often necessitates reference to ASCE Manual No. 38, "Private Practice of Civil Engineering," published in January 1959.* Curves that show engineering fees in percentage of net construction cost in dollars are provided on page 18 of the manual (the accompanying Fig. 1) where median fees are established for works ranging from $100,000 to $100,000,000. Curves for projects of "average complexity" (Curve B) and "above average complexity" (Curve A) are presented which, in each case, include a group of 14 items of professional services (Manual No. 38, pp. 19, 20).

The proper use of the curves as a guide in establishing fees depends upon the recognition of all conditions pertaining to the particular project being considered and to the effect of those conditions on the fee percentages indicated. Two conditions that influence the fee percentage as read from the curves are: (1) a limitation in the scope of the engineering services to fewer than the 14 items included in the curves, and (2) fluctuation of construction costs from those that prevailed when the curves were established. The purpose of this article is to suggest means for adjusting the curves for these conditions.

Limitation of services

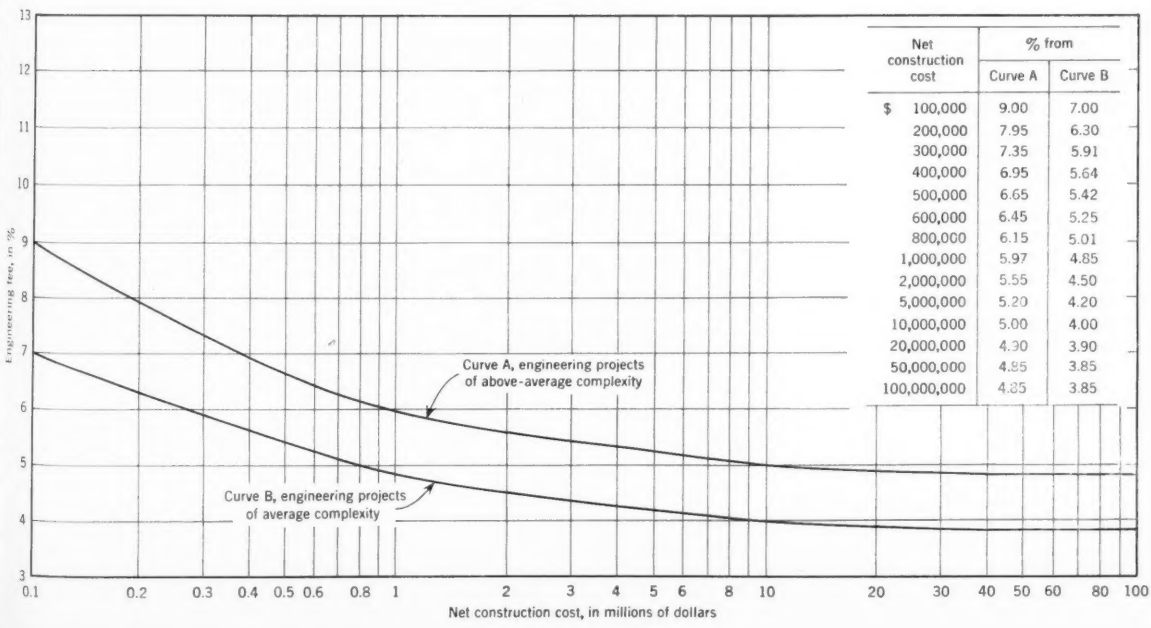
Many engineering engagements do not include all the 14 items of service for which the fee curves were prepared, and thus require a reduction of the established fee because of the elimination of certain items. In 1950

* Manual 38 is available from ASCE, 33 W. 39th St., New York 18, N. Y. Price, $1.00 (50 percent discount to ASCE members).

TABLE 1. Breakdown of Fee Estimates for Professional Civil Engineering Services (Curves A and B, ASCE Manual 38)

Services Covered by Fee Estimates	Net Construction Cost of Project, %							
	$100,000		$500,000		$2,000,000		$5,000,000	
	A	B	A	B	A	B	A	B
A. Report Phase								
1. Preliminary Investigations and Designs and Report	0.98	0.59	0.56	0.34	0.43	0.25	0.38	0.22
2. Engineering Advice in Financing of Project	0.21	0.21	0.11	0.12	0.06	0.06	0.05	0.05
3. Planning and Supervising of Surveys, Subsurface Investigations, and Tests	0.29	0.24	0.13	0.10	0.08	0.06	0.07	0.05
Subtotal for A	(1.48)	(1.04)	(0.80)	(0.56)	(0.57)	(0.37)	(0.50)	(0.32)
B. Plan Phase								
4. Making of Final Designs								
5. Preparation of Contract Drawings	4.81	3.98	4.12	3.56	3.71	3.16	3.65	3.09
6. Drafting of Specifications and Contract Documents for Construction								
7. Estimate of Quantities and Cost	0.41	0.31	0.27	0.23	0.22	0.16	0.20	0.14
Subtotal for B	(5.22)	(4.29)	(4.39)	(3.79)	(3.93)	(3.32)	(3.85)	(3.23)
C. General Supervision Phase								
8. Assistance in Securing Bids, Analysis of Bids, and Assistance in Letting Contracts	0.34	0.29	0.12	0.10	0.06	0.05	0.05	0.04
9. Checking Shop and Working Drawings Furnished by Contractors	0.44	0.25	0.29	0.17	0.21	0.12	0.17	0.10
10. Consultation and Advice During Construction	0.49	0.29	0.34	0.21	0.26	0.19	0.21	0.15
11. Reviewing Estimates for Progress and Final Payments to Contractors	0.31	0.31	0.20	0.20	0.17	0.17	0.14	0.13
12. Assistance in Tune-Up and Test of Equipment	0.29	0.18	0.20	0.13	0.11	0.09	0.09	0.07
13. Preparation of Record Drawings (if required by the specific engineering contract)	0.26	0.21	0.20	0.16	0.15	0.12	0.12	0.10
14. Final Inspection and Report	0.17	0.14	0.11	0.10	0.09	0.07	0.07	0.06
Subtotal for C	(2.30)	(1.67)	(1.46)	(1.07)	(1.05)	(0.81)	(0.85)	(0.65)
Total fee, ASCE curves	9.00	7.00	6.65	5.42	5.55	4.50	5.20	4.20
SUMMARY OF ENGINEERING SERVICES (Excluding Surveys, Land Plots, Printing, and Field Supervision)								
A. Report Phase	1.48 (16.5%)	1.04 (14.9%)	0.80 (12.0%)	0.56 (10.3%)	0.57 (10.3%)	0.37 (8.2%)	0.50 (9.6%)	0.32 (7.6%)
B. Plan Phase	5.22 (58.0%)	4.29 (61.2%)	4.39 (66.0%)	3.79 (70.0%)	3.93 (70.8%)	3.32 (73.8%)	3.85 (74.0%)	3.23 (77.0%)
C. General Supervision Phase	2.30 (25.5%)	1.67 (23.9%)	1.46 (22.0%)	1.07 (19.7%)	1.05 (18.9%)	0.81 (18.0%)	0.85 (16.4%)	0.65 (15.4%)
Totals	9.00 (100.0%)	7.00 (100.0%)	6.65 (100.0%)	5.42 (100.0%)	5.55 (100.0%)	4.50 (100.0%)	5.20 (100.0%)	4.20 (100.0%)

FIG. 1. Median fees for 14 items of professional services as a percentage of net construction cost. The fees are to be adjusted to suit special conditions. (Reprinted from ASCE Manual No. 38, p. 18.)


Engineering fee, in %
Net construction cost, in millions of dollars
Curve A, engineering projects of above-average complexity
Curve B, engineering projects of average complexity

Net construction cost	% from Curve A	% from Curve B
$ 100,000	9.00	7.00
200,000	7.95	6.30
300,000	7.35	5.91
400,000	6.95	5.64
500,000	6.65	5.42
600,000	6.45	5.25
800,000	6.15	5.01
1,000,000	5.97	4.85
2,000,000	5.55	4.50
5,000,000	5.20	4.20
10,000,000	5.00	4.00
20,000,000	4.30	3.90
50,000,000	4.85	3.85
100,000,000	4.85	3.85

our office prepared a "Breakdown of Fee Estimates" to serve this purpose, based on graphs in ASCE Manual No. 29, printed in 1949-1952. This was presented in the January 1950 issue of CIVIL ENGINEERING, p. 53. At that time breakdowns for $100,000, $500,000 and $2,000,000 projects were developed. From correspondence since that time we believe these 1950 breakdowns have been extensively used all over the country.

With the adoption of the new fee curves in Manual No. 38, we made a new breakdown for use in our office. Since it may be of help to others in the profession it has been tabulated and is shown herewith as Table I. As a result of higher project costs, we have extended the data to include projects of the magnitude of $5,000,000.

The breakdown represents the judgment of a number of engineers in this office and is intended to be used as a guide in revising total fees to take into account the elimination of certain phases of engineering services. It should be pointed out that the breakdowns do not establish, and must not be used to establish, guides to suitable fees for small phases of engineering services undertaken as independent assignments without the benefit of the larger elements.

Fluctuation of construction costs

It should be noted that the fee curves shown in Manual No. 38 are based on net construction costs at prices prevailing in 1957 when the Index of Construction Cost of *Engineering News-Record* was 724. (The base for the year 1913 equals 100.) Manual No. 38, on p. 19 (also p. 26) states: "As changes in price levels occur in the future they should be reflected in the application of these curves."

The above means that, in the years after 1957, if inflation or deflation with raised or lowered construction prices has occurred, and on the assumption that engineering costs change proportionately with construction costs, then the net construction cost (actual or estimated) should be multiplied by the ratio of index 724 over the index number then prevailing, and the curves should be entered with this factored construction cost to obtain the appropriate percentage fee to be multiplied by the then net construction cost to obtain the engineering fee in dollars.

Construction costs have risen since 1957. The average *Engineering News-Record* index for 1958 was 759; for 1959, it was 797; and since mid-year of 1960, about 830. These show a 4.9-percent increase of 1958 over 1957; a 5-percent increase of 1959 over 1958; and an increase of somewhat more than 4 percent for the mid-year 1960 over 1959. From 1950 to 1957 the average yearly increase in the index was over 5 percent per year. The total rise in the index from 1950 to 1960, $\frac{(830-510)}{510}$, is 62.7 percent.

Assuming that some time in the future, say the year X, the index has risen some 30 percent over 1957 prices, or to 941, then the construction cost on which the fee curves should be entered must be the cost in the year X multiplied by 724 over 941, or 0.77. As an illustration for use in the suggested adjustment, suppose an estimated or actual construction cost in the year X is $1,000,000. Factored to 1957 conditions, this would produce a cost figure of $770,000, and the appurtenant fee would be (on Curve A) 6.20 percent rather than the 5.97 percent as shown in Manual No. 38. The fee then would be 6.2 percent of $1,000,000, or $62,000 rather than 5.97 percent of $1,000,000 or $59,700.

Mathematical proof of the above is as follows: Engineering services in 1957 on a $770,000 project would carry a fee (Curve A) of 6.2 percent, or $47,000. But by the year X, engineering costs have gone up 30 percent; therefore, for the same services the engineer should receive 130 percent of $47,000 or $62,000. Under our assumption, construction costs will have gone up 30 percent proportionately, to $1,000,000. The fee for the $1,000,000 construction project would be $62,000 or 6.2 percent and not 5.97 percent as shown in Manual No. 38.

In effect, the fee curves should be moved horizontally to the right as construction prices rise, and to the left as construction prices fall.

Percentage fees adjusted as suggested can be broken down into the 14 items of service of Manual 38, taking direct proportion to the nearest fee in the attached table.

Many engineers think it is not completely reasonable to assume that the changes in construction costs, as reflected by the ENR Index, necessarily parallel the changes in engineering costs for any given period of time except as a coincidence. Some of their reasons for this view are:

a. The ENR Index is made up of a combination of items which include both material and wages, as for example, 6 bbl of cement, 1.088 M board-ft of 2 x 4 lumber, 2,500 lb of structural steel, and 2,000 man-hours of common labor. Engineering costs, on the other hand, are made up almost entirely of salaries.

b. Much of the "weight" of the ENR Index is influenced by manufacturing efficiencies, automation, mechanization and the effects of these on supervisory costs, whereas engineering costs are less sensitive to such changes.

c. The construction costs actually experienced, to which fee percentages are ultimately applied, are generally lower than the ENR Index because of the efficiency of contractors, new equipment, productivity of manpower, the competitive market and other factors. It should be noted that some engineers insist that their fee percentage be based on estimated rather than bid construction costs in order to reduce the losses resulting from abnormally low bids sometimes received in periods of severe competition.

d. Advances in the art and the detailed study and research required for the application of more complex design procedures may increase engineering costs while reducing construction costs.

e. Under inflation, engineering costs may increase faster than construction costs.

Conclusions

Four general conclusions are listed in summary:

1. The breakdown of fee estimates under three phases (report, plan and general supervision) and the 14 services going to make up the fee curves shown in ASCE Manual No. 38, should be used with due care and should not be followed without taking other factors into consideration. The breakdown should not be used when considering only one or a few of the services.

2. It is not possible to establish an "exact" price by curves or arithmetic adjustment of them for engineering services because of the many variables. It is possible, however, to establish approximate changes that will form a basis for judgment. It is essential that each project be given detailed individual consideration in order to select the suitable fee.

3. The ENR Index, or any other similar index, should be used as a guide in adjusting the published fee curves but should not necessarily be applied rigidly as a precise computation.

4. The cost of engineering services has apparently increased at a slower rate than construction cost as represented by the ENR Construction Cost Index. The composites of the judgments of engineers who replied to questionnaires for the making of percentage fees as shown in Manual No. 38 were independent of the composites of those used in the making of the earlier Manual No. 29.

Publicly employed engineers in professional society activities

JOHN G. DUBA, F. ASCE, Mayor's Administrative Officer, Chicago, Ill.

This article was presented at the ASCE Boston Convention as part of a panel discussion on "Participation of Publicly Employed Engineers in Professional Society Activities," sponsored by the Department of Conditions of Practice. Mr. Duba discussed the attitudes of public agencies as the employer. His discussion was based on comments from ASCE Local Sections and conversations with representatives of government agencies of all types and at all levels.

From the information available it appears that public agencies, in general, do encourage their employees to join professional and technical societies. At least, very few instances of their discouraging such participation were reported. However, representatives of several agencies indicated that no positive or generally accepted policy had been established.

Further investigation revealed that where policies encouraging participation existed, they had often been established by a superior who was active or had been active in at least one professional society. From my own experience I recall a city engineer in Missouri, a commissioner of public works in Illinois, a highway engineer in Indiana, an engineer with the Bureau of Yards and Docks, an officer in the U. S. Corps of Engineers, a professor of engineering in a state university, and others who, through example or positive action, aided in establishing policies encouraging employees to join and participate in professional and technical societies. In agencies where an individual active in an engineering society has not been in a policy-making position, encouragement to join engineering societies has often been lacking. Such a lack of support of engineering society participation, in my opinion, should be attributed to a lack of interest by the engineers themselves.

The consensus regarding a policy of encouragement to engineer employees to attend local, regional, or national society meetings, granting of time to attend such meetings, and payment of travel expenses was more difficult to obtain. Again, in agencies where professional society leadership was evident, employees, as a general rule, have been encouraged to attend local and, often, state meetings. Because of the time (and sometimes the cost) involved in attending regional and national meetings, participation in the program or membership on committees has been a prerequisite for attendance. Too often employees who have shown no interest in group activity at the local level, still expect to be allowed to attend a national meeting in some exciting convention city.

Fear by supervisors of public criticism of employees on a junket, inadequate staff to perform duties in the absence of certain key employees, budget limitations, and prohibitive regulations have been advanced by some representatives of government agencies as reasons for restricting attendance at meetings that require payment of travel expenses or time off from work.

Almost without exception, however, where participation in a meeting will bring favorable notice or publicity to an agency or government unit, reports indicate that a professional society member receives time off and, generally, travel expenses.

Although about two-thirds of the government units that answered questions about membership and participation of their employees in professional societies indicated that their engineer-employees are encouraged to participate in such activities, a more careful analysis of actual conditions reveals a less optimistic picture. Representatives of many of the agencies, when questioned further, stated that only the more promising engineers or those in selected positions are actually encouraged to participate in their professional society affairs. The remaining one-third of the government units exhibited, at best, an apathetic attitude.

In view of this less-than-satisfactory position on the part of public agencies toward participation of their engineer-employees in society activities, the following questions present themselves:

- Does the governmental unit benefit from this participation?
- If so, what are the benefits?

All of us know, or believe, that the answer to the first question is emphatically "yes." Participation aids in the development of engineers through the exchange of ideas. It can also aid in the recruitment of engineers—an area of interest to all units of government.

Certainly, then, there are mutual benefits to be gained for engineers and their employers—in this case government units—from membership and participation in professional societies.

The societies also benefit from and should take steps to make known the advantages of membership. This is especially true of the American Society of Civil Engineers because of the substantial number of civil engineers in government employ. The government agency can benefit from the many Society services, and the civil engineering profession through larger membership can gain the recognition it deserves but has not yet fully realized.

Thus we must face up to the challenge to present to those in a position of establishing or altering policy the facts regarding society membership and participation. I feel that no engineering society has done an adequate job in this regard.

As a matter of policy, I believe that the American Society of Civil Engineers and the other engineering groups should (1) carry on an aggressive program to induce young men to become engineers and to become registered when they have gained the required education and experience; (2) help engineers achieve adequate public recognition for the services they render or the contributions they make; (3) make certain that only registered engineers are appointed or employed as administrators of technical arms of government; and (4) see that elected officials are made aware of the necessity or desirability of utilizing engineers who are registered and who, through participation in engineering society activities, continue to develop and broaden their sphere of knowledge and interest.

I stress the matter of registration because I have found it is the only true measure of professional status. Without it, a public official may place a civil engineer in the same category as an engine operator or other technician.

Thus I would like to reiterate that although the great majority of government agencies do favor, at least in some degree, participation of their engineer-employees in professional society affairs, a universal policy in this regard will require a positive program of action on the part of the societies, implemented by their active members.

California's water plan

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Well over 70 percent of the natural stream flow in California occurs in the northern third of the state, an area with less than one-third of the total demand. The populous southern part of the state has very meager natural water resources. This is California's water problem. Recognizing its seriousness, California's citizens, when they went to the polls last month, voted in favor of a $1,750,000,000 general-obligation bond issue to finance the construction of specific physical facilities for the conservation of the mountain waters and means for bringing them to areas of need.

The basic problem

The runoff from California streams averages 71,000,000 acre-ft annually. There is enough water but it is not in the right places. The streams of the north coastal region of the state (Eel, Trinity, Klamath, Mad, and Van Duzen) furnish about 41 percent of this total, and the Sacramento River and its tributaries (Feather, Yuba, and American) provide 32 percent. Most of the remaining runoff, or about 16 percent of the total, originates in streams contributing to the San Joaquin River.

Another significant factor in California's water problem is the timing of precipitation. Throughout the state, the bulk of the rain and snow comes in a few winter months, while the summers are dry. Also, California is subject to extended wet and dry periods. In the late 1920's and early 1930's the state suffered a severe drought during which stream runoff for a 10-year period averaged only a little more than 50 percent of normal. At present, California is experiencing another dry period. Last year and this year stream flow dopped to 60 percent of normal, causing serious shortages.

Although runoff from the higher mountain ranges is regulated to a considerable extent by the effect of the mountain snowpacks, most of the stream flow closely follows the pattern of rainfall, and comes during the winter and early spring. The runoff is frequently in the form of damaging floods that are of high intensity and short duration.

Ground-water basins have provided excellent sources of water supply over much of the state and overdrafts on the ground water have supported the economic development of Southern California and much of the San Joaquin Valley. But warning signs have been evident for years. The draft on many of these underground storage reservoirs greatly exceeds the replenishment, and in some instances the overdraft is of such magnitude as to threaten irreparable damage to these natural storage basins. At present California is overdrawing its ground water "bank account" by more than 5 million acre-ft annually.

These problems are being magnified daily by the tremendous influx of new residents and new industries, and by a constantly expanding agricultural economy. California's population has been growing at the rate of about 500,000 persons each year. Its population has more than doubled since 1940 and forecasts indicate that the present population of nearly 16,000,000 will expand to 28,000,000 by 1975.

Each person must be provided with about 200 gal per day for his domestic and industrial needs, and some 1,300 gal a day to grow the food and fiber required to sustain the type of economy we are building. By 1975, the firm water supply must be increased by 6,500,000 acre-ft per year, or about 26 percent of the present consumptive water use.

History of water development

Problems of water development in California are not unique to the twentieth century. They date back to the days of the early Spanish missions in the late eighteenth century. The mission padres, moving north from arid Lower California, were keenly aware of the need for water. They sought locations near streams so that irrigation water would be available for their orchards and gardens. These steps taken by the Spanish padres launched water development in California.

When large numbers of American and European settlers came West in the middle of the nineteenth century, they encountered many of the problems faced years before by the missionaries.

Most of the new arrivals settled along rivers and streams, where water diversion for domestic and agricultural needs was relatively easy. However, as the state grew, water had to be transported over increasingly greater distances.

Initially irrigation water was supplied without the aid of storage facilities, and the water had to be used when available. But it was not long before it was recognized that water had to be stored during wet periods for use in subsequent dry seasons.

The large metropolitan areas were among the first to feel the pressure of ever-increasing water requirements coupled with diminishing sources close at hand. While the accomplishments of the metropolitan districts and the Federal Government have been dramatic, it is the hundreds of local water and irrigation districts of various types throughout the state that have developed most of its water. California played a pioneering role in this district concept of water development beginning with the passage of the Wright Act of 1887. These areas provided the leadership and initiative in solving water supply problems. Their efforts were outstanding in developing remote sources and in crossing mountains and deserts with extensive conveyance systems.

Typical is the accomplishment of the City of Los Angeles which, as far back as 1905, had outgrown its local water supplies and started looking for new sources. The city constructed a 238-mile aqueduct to carry water from the Owens Valley (later extended to Mono County), on the eastern slope of the Sierra to storage reservoirs in San Fernando Valley. The system operates under gravity flow—down from the mountain region into the water-thirsty valleys of populous Southern California.

The Los Angeles Aqueduct soon was followed by another—the Colorado River Aqueduct—developed in the 1930's. In this project Colorado River water is lifted 1,600 ft over mountain barriers by a series of five pumping plants, and transmitted 242 miles across the desert. The Colorado River Aqueduct, which first went into operation in 1941, was named by ASCE as one of the seven Civil Engineering Wonders of the World. It is the longest and largest domestic water supply line ever built, and is designed to deliver 1,212,000 acre-ft yearly at full capacity. (Note: A U. S. Supreme Court ruling is still pending on California's rights to Colorado River water, threatening possible loss to California of much of its entitlement to these waters.)

Other examples of initiative and leadership in water development are afforded by the City of San Francisco and the East San Francisco Bay Metropolitan area in their efforts to meet their growing demands for domestic and industrial water. The Hetch-Hetchy Aqueduct brings water from the Toulumne River watershed in the Sierra by pipeline, tunnel, and canal across the San Joaquin Valley to the storage reservoirs in the San Francisco area. The East Bay area, through the formation of the East Bay Municipal Utility District, has developed the waters of the Mokelumne River at Pardee Reservoir in the Sierra. An aqueduct delivers this water to reservoirs in Contra Costa and Alameda Counties.

Central Valley Project

During the past 25 years, federal agencies have entered the field of water resources development in California. The U. S. Army Corps of Engineers, through its responsibilities for flood control and stream navigation, and the Bureau of Reclamation of the U. S. Department of the Interior, in the interests of conservation and reclamation, have both constructed major comprehensive projects. The U. S. Department of Agriculture is now expanding its flood control and water conservation activities.

California's water problems have long been recognized at the state level. To solve some of them the state developed a master plan in the early 1930's. The initial unit of this plan, known as the Central Valley Project, was authorized by the State Legislature. This was to be a state enterprise, and a $170,000,000 revenue bond issue was authorized to finance its construction and operation. However, because of economic conditions at the time, the bonds were never marketed, and in 1934 California turned to the Federal Government for aid.

Today the Central Valley Project is being built and operated by the U. S. Bureau of Reclamation. It is an immense project with many purposes—to supply water for irrigation, municipal, domestic, and other uses; improve navigation on the Sacramento River; provide adequate stream flows to maintain suitable water quality in the downstream Delta area (which is constantly endangered by salt water intrusion from San Francisco Bay); control floods in the valleys; and generate hydroelectric energy. This project, begun in 1935, is still being expanded a quarter of a century later. Its fundamental concept is to conserve surplus runoff in the north and transfer it to areas of deficiency to the south, principally in the San Joaquin Valley.

Individual regulatory features of the Central Valley Project include Shasta Dam on the Sacramento River, Folsom Dam on the American River, and Friant Dam on the San Joaquin. Major aqueducts, such as the Delta-Mendota and Friant-Kern Canals, convey the conserved water to agricultural lands in the valleys.

Another key unit of the Central Valley Project is the Trinity River Project, now under construction, which will convey Trinity River water

FIG. 1. Proposed facilities to be built as part of the California Water Development Program are shown. Most of these projects are included in the $1.75 billion bond issue voted by California's citizens in November.

through the drainage divide and into the Sacramento River, developing hydroelectric power en route.

These water supply projects by no means comprise the entire water development picture in California. Numerous other projects have been developed, or are being developed, to transfer water from one area to another, as well as local water conservation and flood control programs.

All these projects have certain features in common. One is the tremendous distances to which Californians have had to go to find an adequate water supply. Second is the constant search, continuing today, for new sources. This illustrates the imperative need to plan ahead for new water supplies and to construct the necessary works in time to make the water available when needed.

California Water Plan

The state has long realized the importance of its role in the coordinated development of its water resources. In 1947, it launched a long-range program to study the entire scope of these resources and their development. First, an inventory was taken of the water supplies available within its borders; then the water requirements, both present and future, were estimated. After a decade of study, plus expenditures of over $8 million, the California Water Plan has been evolved—a master plan for ultimate water development in California, encompassing projects of the state, federal, and local government as well as of private organizations. The plan is purposely designed to be flexible and adaptable to changes as the state's future growth may dictate. It offers possible solutions to many water problems by outlining specific physical projects that can be built when and if found feasible from an engineering, economic, and financial viewpoint. See Figs. 1 and 2.

With this so-called "Master Plan" in hand, the state is in a position to begin fulfilling its obligation as the principal agency to provide statewide water resources development. It was evident that the only solution to the problem lay in the construction of major engineering works to transport surplus waters in the northern part of the state more than 700 miles to areas of deficiency in the central and southern sections. The State Water Resources Development System is a physical engineering program to meet this immense challenge head on.

The critical problem was financing. This, the State Legislature agreed, was the first move in any permanent solution of the state's share of the water development program. In June of 1959 a fiscal plan for state water development was adopted by the legislature. Known as the Burns-Porter Act, it was approved by the voters in November 1960, as previously mentioned. It provides for a general-obligation bond issue of $1,750,000,000 to finance the construction of specific physical facilities to launch the state "full scale" in the water business.

Physical works

The consruction project consists of a system for conservation of the mountain waters and their transportation to areas of need—a system longer and more complex than any heretofore attempted. Here is a brief sketch of the main works in this program, starting in the north and proceeding southward:

1. Oroville Dam and Reservoir. This earthfill dam, 735 ft high (25 ft higher than Hoover Dam on the Colorado) will require 80 million cu yd of material, have a crest more than a mile long, and provide a storage reservoir of 3,500,000 acre-ft with a shoreline 167 miles long and a maximum water drawdown of 400 ft. The estimated cost is $457 million.

2. Other Oroville features. A power plant of 600,000-kw capacity is to be built in the left abutment, plus a downstream diversion dam, a 105,000-kw power plant, a power canal, and afterbay.

3. Upper Feather River Projects. Five small dams and reservoirs are to be built upstream from Oroville, primarily for recreation and irrigation needs in the high Sierra country.

4. Delta Water Facilities. A system of master levees, control structures and channel improvements are to be built for water conservation, flood control, salinity control, and water supply in the Sacramento-San Joaquin River Delta. This project will also provide for transfer of water across the delta as well as meeting the water needs of the Delta area itself.

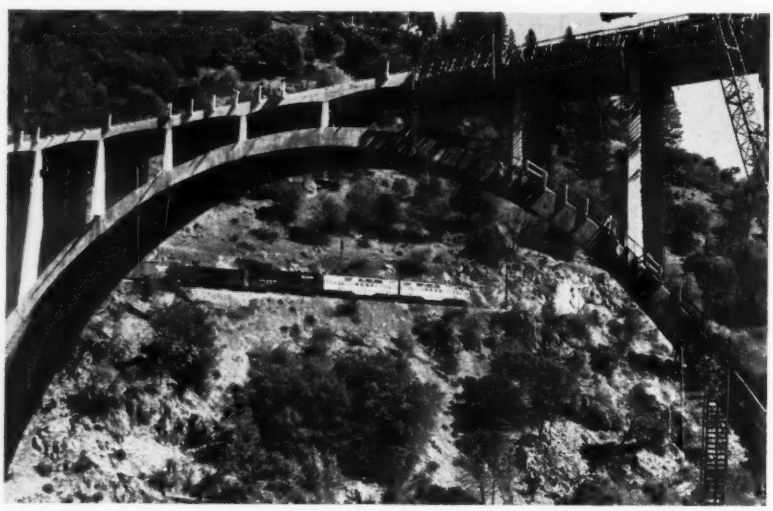
5. North Bay Aqueduct. A 60-mile aqueduct is to be built from the Sacramento-San Joaquin Delta across four north San Francisco Bay counties.

6. South Bay Aqueduct. A 45-mile aqueduct will carry water from the Delta to serve the South San Francisco Bay area.

7. San Luis Dam. A joint state-federal earthfill dam and a reservoir of 2 million acre-ft are to be built in Merced County, 50 miles south of the Delta, at an estimated total cost of $400 million. This project will serve the Federal Government's needs in the adjacent area as well as providing en route storage along the state's main aqueduct line into the San Joaquin Valley and Southern California.

8. San Joaquin Valley-Southern California Aqueduct. An aqueduct running from the Delta south along the western slope of the San Joaquin Valley, with branches over the Coastal and Tehachapi Mountain ranges, will serve the San Joaquin Valley and the vast metropolitan and semi-arid regions of Southern California. The total length will be 650 miles.

For the past three years, work has been progressing at the Oroville Dam site, relocating highway and Western Pacific Railroad facilities. Some $34



Center arch of the triple-arch reinforced concrete bridge which spans the North Fork of the Feather River is shown under construction. In the background the Western Pacific Railroad is seen at about the point where the relocated line around Oroville Reservoir will meet the existing line.

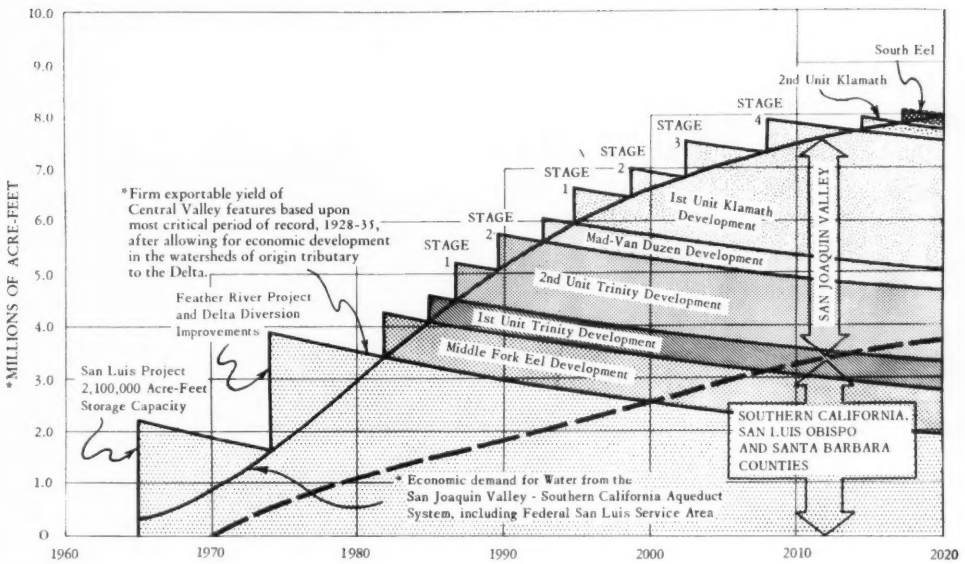


FIG. 2. Scheduling of major stages in California's Water Development Program, to meet anticipated population increases, is shown graphically.

million has been appropriated for relocating 27 miles of railroad to the west of the reservoir site, as well as 20 miles of highway. The Western Pacific relocation includes construction of five tunnels and three bridges. The tunnels total 21,730 ft in length, the longest being 8,830 ft, the shortest 2,750 ft. The three bridges are: (1) the Main Feather River Bridge, an 1,100-ft steel-girder structure just north of the City of Oroville; (2) the North Fork (of the Feather River) Bridge, a concrete arch 1,011 ft long, located at the northern-most extreme of the future reservoir; and (3) the West Branch Bridge, a double-deck truss bridge, providing on its upper level four lanes for the relocated highway 40A (2,732 ft. long) and on its lower level a single-track rail line (1,800 ft long).

All the relocation work is due for completion by the summer of 1962, when actual construction of Oroville Dam can begin. Meanwhile, work has begun on two other phases of the Statewide Water Project. The first 15 miles of the South Bay Aqueduct into Livermore Valley is under construction, and first water deliveries are slated for early 1962. Next year will see completion of the Frenchman Dam and Reservoir, the first of the five small projects in the Upper Feather River basin, upstream from Oroville Dam.

The state estimates its average annual construction expenditure for the next 25 years at $75,000,000. In contrast, its highway construction program calls for annual expenditures nine times that amount.

The use of atomic energy has also come into California's water picture. A study is being made of nuclear power as a future source of energy for some of the huge water conveyance tasks, and also as an economical means of some day converting sea water to fresh.

Benefits cited

The principal benefit of this long-term project obviously is the delivery of adequate water supplies to areas with serious deficiencies. Nearly 4 million acre-ft of water will be transported to various parts of the state annually when this project is in full-scale operation in the year 1990. The largest share will go to the San Joaquin Valley and Southern California, but areas such as the South San Francisco Bay and Santa Barbara and San Luis Obispo Counties also will benefit.

Southern California will receive nearly 1.8 million acre-ft per year by 1990 at an average cost of $59 per acre-ft. First deliveries are slated for 1971.

The San Joaquin Valley, mainly in Kern County, will get an annual delivery of about 1,500,000 acre-ft by 1990 at an average cost of $16 per acre-ft. First deliveries there could be made in 1968.

In the coastal counties of Santa Barbara and San Luis Obispo, the 1990 annual supply would be 128,000 acre-ft at a unit cost of about $54 per acre-ft. First delivery is seen by 1971.

In the South San Francisco Bay area, where the aqueduct already is under construction by the state, the first delivery could be made in 1962, with a 1990 total of 210,000 acre-ft per year, estimated at $25 per acre-ft.

Aside from the water supply benefits, the program will greatly enhance the state's over-all economy. Recreation for a public with an increasing amount of leisure time is also playing a key role in the program.

One thing should however be made clear: this program in no way implies that the State of California intends to "go it alone" in meeting its present and future water requirements. Full encouragement will be given the continuation of federal, local, and private development in so far as these projects are coordinated within the master state-wide plan.

In summary it should be emphasized:

1. Water supplies must be developed in advance of need.

2. Construction of major water projects such as these take years to complete and the time of need is now.

Had it not been for the farsightedness of men such as Mulholland with regard to the Los Angeles Aqueduct and O'Shaughnessy in working for San Francisco's Hetch Hetchy system, neither of those cities could have developed into the metropolis it is today. Had the works of the great Central Valley Project not been in operation this year—one of the driest on record—much of California's valley agricultural area would have been without water.

We cannot afford to delay in moving forward with the new projects so urgently needed now. The task ahead is gigantic. The combined efforts of all levels of government are required if this great state is to continue to grow and prosper.

The rail commuter problem

W. W. PATCHELL, Vice President, Special Services, Pennsylvania Railroad, Philadelphia, Pa.

One of the most serious problems facing metropolitan communities today is that of moving people between their places of residence and business at minimum total cost. Such total cost must include the initial investment and the continuing expense to the riders and to the community as a whole.

There has been much publicity on this subject and much thought has been given to it. The problem has many economic aspects. Under present conditions, with government changing the rules of the game and providing competition without proper user charges, private enterprise has not been and will not be able to retain suburban railroad services for communities except at a loss.

In the past, suburban railroad services were feeders for a large inter-city passenger business. This suburban business diminished, as through passenger traffic was diverted because of government expenditures for other forms of transport that use facilities provided by the public. Many of the feeder suburban rail services have been eliminated, and the remaining ones actually are no longer feeder services but are primarily carriers of peak loads to metropolitan areas. No private enterprise—completely regulated by government—can compete with government-supported facilities, nor can private enterprise with regulated fares held down by government regulation compete with the inflation resulting from government action.

As a result of government regulation and the artificial pricing of competing forms of government-aided transportation, railroad coach fares today are only slightly above the 1921 level. See Fig. 1.

It will be recalled that the aviation industry started to grow in the middle of the depression. Airline fares originally were fixed right above the rail rates, so that they acted as a ceiling on railroad coach fares. From that date to this, all levels of government have continued to spend hundreds of millions of dollars a year for air traffic control, airports, and research in aviation. We are not criticizing these expenditures. What we are criticizing is the fact that the people who use these services are not paying their full total cost, and as a result artificial competitive prices hold coach rates down.

Recently the airline industry complained about an artificially supported price ceiling. President MacIntyre of Eastern Airlines raised the question of whether air transportation can survive as free enterprise, stating that "too much competition under a price ceiling that was too low has so inhibited profits that private enterprise may not be able to finance the further increase in capital necessary for complete transition to the jet age." We know what artificially supported prices have done to us and how they have affected the suburban transportation problem.

Originally, with suburban travel as a feeder to through rail service, the so-called commutation rates came into existence and were fixed initially on an additive revenue base. For example, in 1921, the average commutation rate amounted to only about one-third of the regular basic coach rate. The basic coach rate is now only 20 percent above what it was in 1921, while as a result of inflation, the average cost of labor and material has increased 300 percent. This does not mean that the railroads have spent that amount—because they have not had it to spend.

Commutation fares have increased to about double what they were in 1921, but the commutation yield per passenger mile is 15 percent less than today's basic coach yield and only 90 percent of the basic coach rate in 1921. A second reason for loss is that the necessary services and expenses are determined by two peak loads, each with a duration of less than two hours each day. See Fig. 2.

With a two-hour peak load twice a day, five days a week, the equipment and crew requirements of the railroads are determined by only 20 hours of service a week. Of the equipment and crews required for peak loads, 80 percent are not needed at other times. Throughout the country metropolitan and suburban bus lines are faced with the same problem.

The worst part of the picture is that in spite of continuing expenditures for highways, peak loads on the Pennsylvania's suburban rail lines have increased. Comparing 1940 and 1958, the total Philadelphia suburban peak load shows an increase of 65 percent, and on our Paoli or Main Line, an increase of 146 percent.

Railroads cannot afford to furnish service regulated as to quantity and price for such peak loads to save further government expenditures because the income from such operations does not meet costs.

The railroads have maintained these unprofitable services in the public interest, because of public demand. However, in some metropolitan areas, the effect of the highway program has been to wipe out mass suburban rail networks. One example is Los Ange-

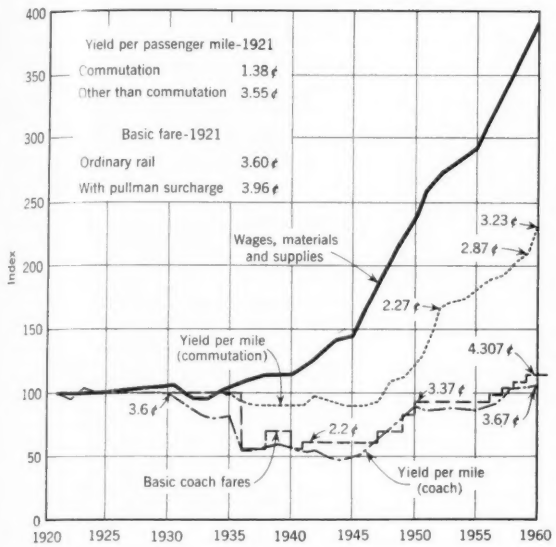


FIG. 1. Basic coach fares on Pennsylvania Railroad are compared with hourly wage and material costs of Class I Railroads. Base is 1921 = 100 percent. Yield per passenger mile in 1921 was 1.38 cents for commutation and 3.55 for other than commutation.

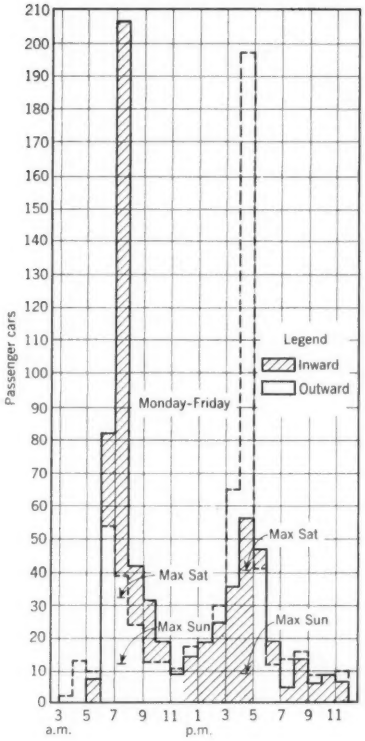


FIG. 2. Suburban-train passenger cars in service are plotted by hours of the day into and out of Philadelphia in October 1959. Note two peak periods.

les, where suburban rail systems once operated 2,300 scheduled trains daily on 50 branches. Today, Los Angeles has no suburban rail passenger service, although the engineering phases of reinstalling such a system are under study. At present, the city relies on highway transportation and is experiencing ever mounting congestion on its streets and elaborate freeways. See Fig. 3.

Two-thirds of Los Angeles for traffic

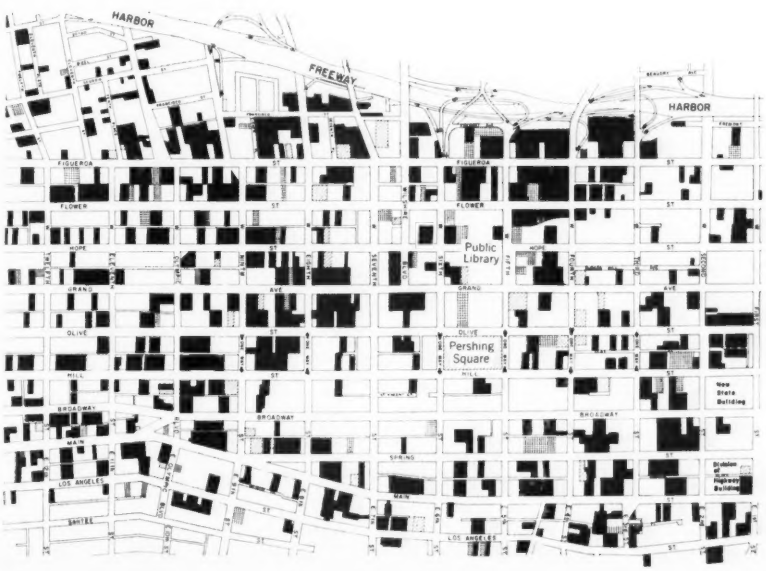
Over two-thirds of the total land in downtown Los Angeles is now devoted to various highway and parking facilities. Over half of the land not used for streets and highways is devoted to parking. Try to visualize your own home town and your tax bills if a similar use of land for highways and parking prevailed there.

It is more economical from the standpoint of the community to carry these peak loads by rail than to attempt to build enough superhighways to carry them. In December 1953, Mayor Clark of Philadelphia appointed a Citizens' Committee to study the congestion of downtown Philadelphia and determine what should be done. This Board, on which I served as a representative of the Pennsylvania Railroad, was known as the Urban Traffic and Transportation Board. The solution it proposed in 1955 was based on adequate user charges. The program included the provision of radial toll highways for movement in and out of the city, with proper charges to regulate the flow of traffic, and at the same time to finance the development and operation of mass transportation facilities to carry peak loads. These, it was found, could be moved into and out of the city most economically by rail, and they must be so moved if the center of the city is to survive.

The Interstate Highway Act of 1956 virtually eliminated tolls and so wiped out that solution of the problem. An odd part of this Highway Act is that it diverted over $700 million annually of excise taxes from general tax funds into what were called user charges for the support of the Interstate Highway system. Right now a tremendous effort is being made by the oil companies and other interested people to divert additional dollars from general funds, which come from excise taxes.

It is of considerable interest that in 1957 all forms of government in the

FIG. 3. Over two-thirds of the land in downtown Los Angeles is now devoted to highway and parking facilities. Black areas are parking lots and hatched areas are garages.



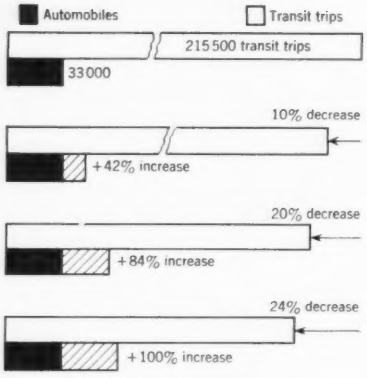


FIG. 4. Effect of rush-hour diversion from mass transit to auto travel is plotted. Note that a 10-percent decrease in rapid-transit trips would produce a 42-percent increase in auto travel.

United States spent $9 billion for highways and received only $6 billion from all user taxes. In that one year general tax funds supplied $3 billion for the highway systems, and the situation since has been similar. In that same year of 1957, some $96 million was taken from general tax funds for the development of inland waterways and over $25 million for the airway system, not to mention airport construction costs and direct federal subsidies. Since that time, expenditures for airways have tripled, Total expenditures on the airway systems now amount to almost $3 billion and are at present progressing at the rate of one-half billion dollars a year.

Last year, the City of Philadelphia spent $18 million from general tax funds for its highway system, plus another $10 million for highway police and traffic control—over and above user charges or contributions. The City of New York spent over $100 million for similar services. In other words, the commuter by automobile is being financed out of general tax funds and is not paying his way—and the same is true for the commuter by bus. The Pennsylvania Railroad paid $1,520,000 in taxes to the City of Philadelphia in 1960, and paid New York City about $5,000,000 in real estate and franchise taxes.

Much criticism has been heard about railroad equipment, pricing, merchandising and lack of midday service. We have tried experiments with reduced-fare shopper tickets, improved service, and rearranged schedules—but as private enterprise the financial results are just as bad as they were before.

Following the demise of the Urban Traffic and Transportation Board's 1956 proposed solution for Philadelphia, the Pennsylvania Railroad and the city worked diligently to find some way to carry out this program. Unfortunately, it involved moving into the total metropolitan area, and the attitude of most areas toward that problem today is well known. However, after many negotiations, almost two years ago we started an experiment that has become known as "Operation Northwest," in which the Reading Railroad and the Philadelphia Transportation Company are cooperating.

On the Pennsylvania's Chestnut Hill Line, services were increased up to 50 percent and fares were cut as much as 45 percent. The city paid a part of the cost of the increased operations. The railroads continued to assume the risk of losses, which have increased because of increased expenses, a decrease in gross revenue, and an increasing peak load. From the railroads' viewpoint, these innovations have been a financial failure, but from the standpoint of the city, they have been a huge success because they have increased the number of rail riders and have taken a great number of automobiles off the highways and out of the center of the city. Each year the number of passengers carried has run well above that of the previous year. However, the same bugaboo of peak-hour loads is with us and these loads have increased.

While other lines in the Philadelphia area have shown a yearly decrease in total passengers carried, the Chestnut Hill service has shown a steady increase, the peak loads on this Pennsylvania line in 1960 being 31 percent above a year ago. There can be no question that reduced rates will influence more commuters to take trains rather than automobiles, particularly in peak periods, and thus save the city money.

Basically a financial problem

The big question is how to solve the financial side of the suburban transportation problem. This solution can be found by any one of three methods:

1. The railroads can be given complete tax relief and complete freedom to provide service and schedules at rates that will produce a fair return.
2. The railroads can be permitted or ordered by government to get out of suburban transportation business.
3. Government can assume its responsibility for this problem.

Granting complete freedom to the railroads for the solution of the problem may mean reduction of service and an increase in fares, and possibly the eventual discontinuance of all passenger service. The Long Island Railroad, however, is an example of one approach to such a problem. The Long Island was given almost complete freedom of rates, but that freedom has since been restricted by political maneuvers. It was also given a 50-percent reduction in taxes and would appear to be operating in the black, but the reorganization agreement prohibited any return to the owners of the property during a twelve-year reorganization period. While the Pennsylvania Railroad—which owns the Long Island—was obliged to agree to this program, it amounts to virtual confiscation of private property.

As in this instance, in fact in all suburban service, the railroads today are actually subsidizing the public and the community. This they cannot afford to do. Either of the first two methods will quickly solve the railroads' suburban problems. However, it will not solve the problem from the standpoint of the public.

If government fails to assume its responsibility, the suburban rail services must continue to shrink and eventually to be replaced by throughways, as has happened in Los Angeles.

To find an answer, we made a study of what would happen in the Philadelphia area if highway expansion were continued in the attempt to take over the Pennsylvania's entire suburban load. It would cost $611 million for additional highway facilities just to carry our present suburban train peak-load volume by highway in the manner in which highways are now built and people are now moving.

The Pennsylvania's loss on the Philadelphia suburban service in 1957 was $4 million, excluding consideration of investment. Certainly it is not economical to spend $611 million (borrowing the money at 4 percent would cost $24 million annually in addition to the cost of operating and maintaining the additional facilities) or even half that amount when the same purpose could be accomplished if a public authority spent $4 million annually to purchase a needed service.

However, there is a much greater problem to be faced than that of cost alone. It is the practicability of attempting to do this with highways. The Highway Traffic Engineer of Los Angeles, the Chief Engineer of New York's Triborough Bridge and Tunnel Authority, and the New Jersey State Highway Commissioner have all stated that highways are not the answer

to the problem of carrying peak loads. Even the Port of New York Authority recognized this fact in announcing the expansion of its Bus Terminal when it stated that even with the newly expanded terminal the Port Authority would still be dependent on the continued availability of existing suburban railroad lines.

The reason highway authorities take this view is self-evident from a study based on Philadelphia's peak-hour traffic, which shows that a 10-percent reduction in mass transit volume would produce a 42-percent increase in auto travel; a 20-percent reduction, an 84-percent increase; and a 24-percent reduction, a 100-percent increase (Fig. 4). These are not the railroad's estimates, but were prepared by the City of Philadelphia on the basis of actual experience.

Not only is it impossible to solve this problem economically with highways, it is cheaper to move peak loads by suburban rail lines because:

1. Each lane of railroad track can handle as many people per hour as 20 lanes of superhighways.
2. It is impossible to build enough highways for this purpose.
3. Peak loads immediately cause highway congestion.
4. Enough automobiles cannot be moved into downtown areas because of lack of access and lack of room for automobile storage.
5. Expansion of the highway program into the downtown area would further destroy the tax base.

Toronto's subway proves valuable

An interesting contrast is the experience of Toronto, which just six years ago inaugurated its first subway system. This subway has encouraged redevelopment and new development along its entire route. Since subway construction began, property has become more valuable and assessment increases of 79 and 93 percent have taken place in two of the subdivisions immediately adjacent to the subway. The significant thing is that instead of destroying downtown property values, the subway has virtually paid for itself because of a resulting increase in city revenues of about $5½ million annually. For these reasons Toronto is now expanding its subway system at a cost of $220 million.

The basic question is what can be done to retain the central cores of metropolitan areas so that they can continue to do business and preserve as far as possible the surrounding suburban communities. Or, if it be decided to wipe out the central core of the city, as some have suggested, then we should wipe out the suburban rail lines and their peak-load capacities and go forward with the highway program with the resulting elimination of both the city and the suburbs.

Can our cities be saved?

The final solution must be in the hands of the local areas served. A metropolitan district organization should be established, as in Toronto, to arrange for total transportation programming and operation, including highway, suburban rail, and rapid transit. The efforts of this organization should progress in the following order:

1. It should contract and pay for the use of existing facilities and the operation of such services as it determines the public requires.
2. It should find a means of financing new equipment.
3. It should find a means of providing funds for improvements and replacements.
4. It should provide funds for the expansion of services and facilities.

This practical approach goes back to the basic recommendations of the 1955 Urban Traffic and Transportation Board Report to the Mayor of Philadelphia. Out of these recommendations came the basic concept for the experiment on our Chestnut Hill Lines previously described as "Operation Northwest." From that experience grew what is now known as "Operation Northeast" on the Reading Railroad. These experiences in turn led to the agreement to continue these operations on an additional line of the Reading in "Operation Shawmont" and on two lines of the Pennsylvania in "Operation Manayunk" and "Operation Torresdale."

To carry out this program, the City of Philadelphia in cooperation with the railroads and the railroad labor unions has set up a non-profit corporation known as "The Passenger Service Improvement Corporation." This corporation receives its funds from the city and from the revenue from these operations. In turn, it pays the railroads under specific agreements certain amounts that change from year to year.

The agreements for the year 1960 for "Operation Northwest" and "Operation Northeast" have been executed. The agreements for the expansion of the other services mentioned have been executed, and the agreement for the continuation of all these services for the year 1961 will probably be executed before the first of the year. The basic factors in this problem have not changed. The railroads no longer can subsidize the community. However, the problem is area-wide and not just city-wide.

To solve this problem, one of the three alternative solutions suggested ultimately will be used. For the benefit of the Greater Philadelphia area and its citizens this should be an expansion and a continuation on an equitable basis of railroad suburban service through the non-profit Passenger Service Improvement Corporation. This will of course require cooperation and financial support from the surrounding communities. It will take time and education.

New Jersey seeks a solution

The State of New Jersey is rapidly putting into operation a program by which the railroads are paid certain sums to continue their suburban rail services. These sums are insufficient to make up the losses, but at least they are a beginning.

In New Jersey the solution to the problem may well move in the same direction as in Philadelphia. It could also move in the direction of a Tri-State Transit Authority, as some have suggested, but it will still have to move toward the same basic objectives, because, to preserve the communities and to save money for them and their citizens, the existing suburban rail services must be preserved. Private enterprise in the form of suburban railroads cannot afford to compete with the super-government that furnishes super facilities without adequate user charges.

Local conditions will no doubt require a variety of solutions. In some areas, as in Chicago, rapid transit will be an aid. All areas will need some highways. Los Angeles is considering rubber-tired trains, primarily because of grades. Some very special conditions may warrant a monorail, but where the existing rail facilities can be used or reclaimed for suburban service, it would be sheer folly to throw them into the discard. Of course, it will be fine eventually to provide the most modern equipment and operating controls, but the first problem is to arouse government to its responsibility, and the time remaining to do this is very, very short.

The time for action is now. Because this is a public problem, engineers have a civic responsibility to see that government assumes its full responsibility and takes prompt and effective action.

(This article is based on Mr. Patchell's paper presented at the ASCE Boston Convention, before a City Planning Division session.)

Solids-contact units for water treatment

Part 1: Introduction and design features

A. A. KALINSKE, F. ASCE, Vice President and Technical Director, Infilco Inc., Tucson, Ariz.

The most significant development in water treatment practices and equipment since the invention of the rapid-sand filter about sixty years ago is the introduction some twenty years ago of the so-called suspended-solids-contact plant. Initially such plants were confined to smaller installations and were used exclusively for lime or lime-soda softening, since it was clearly demonstrated that "solids-contact" was extremely beneficial for carrying out the softening reactions.

As experience was acquired in the design and operation of these plants, larger units were built. Because of the economic advantages they offered on the basis of first cost, they began to be considered for the clarification of turbid and colored surface waters. Since in most cases the economics are favorable, the use of this type of treatment plant preceding rapid-sand filters has accelerated during the past decade. In addition to economic considerations, data have demonstrated the advantages of the solids-contact process over so-called conventional pretreatment methods.

Not only are there some 500 municipalities in the United States now using solids-contact treatment plants but there are also many thousands of industrial installations. There are also about 400 municipalities outside the United States that are now using plants of the solids-contact type for water clarification. In size these installations range from single units with a capacity of less than 10,000 gal per day, to multiple-unit plants of 130 mgd, with single units rated at 35 mgd.

General description

A solids-contact unit incorporates in a single unified structure the processes of mixing, coagulation and flocculation, floc conditioning, liquid-solids separation, and automatic sludge removal. Raw water and chemicals are mixed in the presence of previously precipitated solids which have been retained in the process without being allowed to settle. Thus the chemical reactions are accelerated and colloidal precipitates are avoided, since the precipitation occurs on the surfaces presented by the old floc particles. Therefore the formation of fine precipitates, which require appreciable time for agglomeration, is avoided and also the floc particles are being continually densified, thus increasing their settling rate.

Mechanical mixing at properly controlled velocities is essential since relatively small quantities of chemical must be thoroughly mixed with a large mass of water, and in addition a certain amount of previously formed solids must be kept in suspension and in contact with the incoming raw water. Impellers of relatively slow speed are the most economical means available to accomplish the mixing.[1] The steps of mixing, coagulation, and floc conditioning are normally accomplished in periods varying from 15 to 30 min, depending on the treatment employed and the temperature of the water. This period can be referred to as the solids-contact time, and the action obtained in this period is all-important for the proper performance of a solids-contact unit.

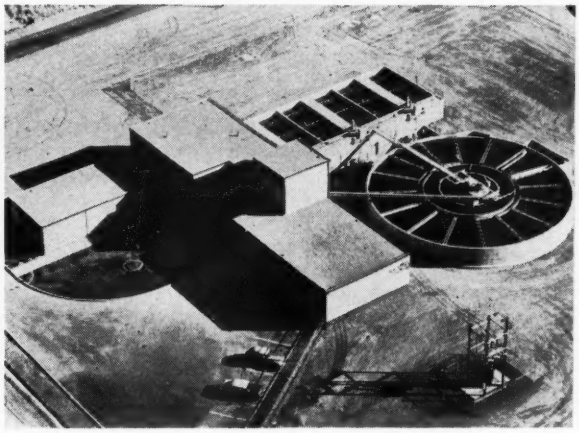
The liquid-solids separation, or clarification, step is controlled to a large degree by the settling rate of the precipitates produced. The inherent design of solids-contact units makes it convenient to utilize the upflow principle in designing the clarification zone or compartment. By proper design of the effluent collecting system practically vertical velocities can be maintained in the entire clear-water zone. This is accomplished by the use of a radial, concentric, or transverse launder system. The size of the clarification area is determined on the basis of the settling velocities of the particles kept in suspension and circulated in the "solids-contact" zone. The more accurately the settling velocity is known, the less need there is for a factor of safety in determining the size of the clarification area. The writer has discussed this subject in a previous paper,[2] and Bond[3] has made an excellent analysis of the settling of suspensions encountered in water treatment.

It is thus seen that so far as overall basin design and dimensions are concerned, the only two pertinent factors are the time in the solids-contact zone, and the permissible upflow rate in the clarification zone. Total retention time is obviously of no significance, as Camp[4] has also pointed out so clearly in regard to so-called conventional basins with horizontal flow.

Important design features

After observing hundreds of solids-contact units of various designs, the writer concludes that the following are the necessary design features of a solids-contact unit if maximum benefits, both technical and economic, are to be obtained:

1. Rapid and complete mechanical mixing of the chemicals with the raw water and a suspension of solids.
2. Mechanical means for constantly circulating, at properly controlled velocities, large volumes of liquid containing the solids used for contacting. This circulation should be accomplished by a relatively slow-speed impeller. The maximum speed should not exceed 5 fps and the liquid volume circulated should be of the order of 3 to 5 times the design throughout. A 3-to-1 speed variation should be provided for any circulator.
3. Means should be provided for readily varying the suspended solids concentration in the contacting zone.
4. The optimum solids concentration should be maintained by automatic discharge of excess solids, after



Of the thousands of solids-contact units being used throughout the country, by far the majority are industrial installations. Here, shown at left, are multiple units in use at the water treatment plant of the St. Regis Paper Company in Jacksonville, Fla. At right is the municipal water treatment plant at El Centro, Calif., which employs a single solids-contract unit.

proper thickening in concentrators or hoppers. The sludge discharge should be controlled by an easily adjustable timer controlling hydraulic or pneumatic actuators.

5. The clarification area should be of such size that the upflow velocity will be at least 50 percent below the particle settling velocity, at a point at least 5 ft below the point of effluent take-off.

6. An effluent launder take-off system should be provided so that substantially vertical velocities will be maintained in the so-called clear-water zone. In general, it is wise to have a take-off system so as to limit the maximum horizontal movement of clarified water to about 3 times the clear-water depth, or according to the limitation in feature No. 5, above, to about 15 ft.

Equipment manufacturers have incorporated various other features in their solids-contact units. Some of these might be desirable in certain cases, and the consulting engineer should make the decision as to whether they are needed or not. In some cases, bottom scrapers are needed; this is true if the raw water brings in sand and grit which cannot be kept in suspension hydraulically in the unit. Also, scrapers may be indicated under certain operating conditions when particularly heavy solids are produced in the treatment unit.

Solids-contact units have usually been built in circular basins; however, square and rectangular basins have been used and are entirely practical if space and construction costs indicate that such shapes are preferable.

The increased use of solids-contact units has been primarily due to their lower first cost as compared to so-called conventional plants. However, there have been instances, especially in connection with softening plants, where this type of unit was chosen because of its inherent advantages in efficiency of chemical utilization and completeness of chemical reactions in softening treatment. Serious study of softening treatment will, in the writer's opinion, always indicate that a solids-contact unit should be used.

Effluent quality excellent

Records from hundreds of clarification plants employing solids-contact units have shown that their effluent quality is excellent. Average effluent turbidity is usually less than 5 ppm. Hazen[5] has presented some data comparing plants in the eastern United States treating river waters without use of any so-called coagulant aids. The data indicated that comparable effluent turbidities (below 5 ppm) were obtained in solids-contact-type plants at hydraulic surface loadings two to three times those in horizontal-flow basins.

The limited data available regarding the physical removal of bacteria and algae indicate that solids-contact units are apparently distinctly superior to conventional settling basins. Mallmann and Kahler[6] reported on a very significant study they made at Michigan State University comparing bacterial removals by lime-alum and alum-clay flocs in a conventional 4-hour settling basin and in a 1-hour solids-contact unit. The surface loading was also about four times greater in the solids-contact unit. The tests, which were made on equipment of small size under accurately controlled conditions, revealed superior removal of bacteria in the solids-contact unit, even at one quarter the retention time and four times the surface loading as compared to a conventional basin. This is undoubtedly related to the ability of the solids suspension to absorb or enmesh bacteria, and thus remove them from the water that is being treated.

More important than the physical removal of bacteria is the removal of

Some four hundred municipalities outside the United States are using solids-contact units for water treatment. Shown here is the municipal plant at Sao Paulo, Brazil.

algae. High concentrations of algae getting onto filters causes greatly reduced filter runs. There is general agreement that in a solids-contact unit superior removal of algae can be obtained as compared to conventional settling, because of the actions of enmeshment, entrainment, and filtration in the suspension of solids maintained in such a unit.[7,8]

Use in United States

The prevalance of solids-contact units in various states is largely dependent on the regulations and attitude of the particular state deparment of health or other regulatory agency. For instance, in the two states adjacent to Florida there are no municipal solids-contact units while in Florida there are about 50 such units and in Louisiana there are about 40. Certainly the presence or absence of solids-contact units in any particular state cannot be correlated with the characteristics of its raw waters or the quality of the operating personnel. In states where solids-contact units are absent the regulations drastically restrict the use of such units, and arbitrarily set up standards that make their use uneconomical. Obviously, such regulations and standards cannot be technically sound in one state and not in an adjacent state.

Solids-contact units must, of course, be specifically designed for each particular water treatment problem, and no general rules as to size can cover each and every situation. Many states feel that it is necessary to maintain certain strict standards for retention time and surface loadings. No harm is done if such standards are set up for the purpose of providing protection against obviously poor designs; however, they must be flexible so that if scientific evidence is presented indicating that shorter times and higher surface loadings can be used, the consulting engineer can present such data for consideration by the regulating agency.

Use outside the United States

Over 400 municipalities outside the United States have solids-contact units. The average size of these plants is appreciably greater than those in the United States, as it is usually only the larger cities in other parts of the world that have modern water treatment plants. Except for a few softening installations in Europe, practically all these plants are for the clarification of surface waters. In general, the decision to use a solids-contact unit in foreign installations is made entirely on the basis of economics. Also, the absence of regulations and standards governing the design of coagulation and clarification basins has permitted such plants to be designed entirely on the basis of technical considerations, as they apply to the particular treatment problem.

It is of interest to note that, except for one particular design, all solids-contact units installed throughout the world are patterned after the designs of United States equipment manufacturers. In most foreign countries the internal mechanism, wherever possible, is of reinforced concrete instead of steel, which is the material used in the United States and Canada. The difference in the relative cost of reinforced concrete and steel for fairly complex partitions, in foreign countries and in the United States, accounts for their use of reinforced concrete wherever possible.

The outstanding advantage of solids-contact units that has been principally responsible for their increased use is their lower initial cost. However, if the full economic advantage is to be obtained when a solids-contact plant is designed, it is very important to obtain complete information on water characteristics, treatment to be used, and settling characteristics of the floc produced. Scientific design principles must be employed and no dependence placed on outmoded practices and rule-of-thumb guides. It is hoped that such impediments to progress in sanitary engineering will be gradually removed. Considering the hundreds of successful plants of this type in all parts of the globe, surely the evidence is overwhelming that we are not dealing any more with "new and untried" ideas.

(This article is based on Mr. Kalinske's paper presented at the ASCE Boston Convention, before a session of the Sanitary Engineering Division.)

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Part 2.

The solids-contact water-treatment units at Omaha, Nebr., comprise the largest installation of its kind in the world. However, certain features of the design are more significant than size. Problems of flow control, chemical-feed distribution, sludge disposal, and ice interference had to be overcome, and some of the solutions to these problems were unique. The units were designed to provide for either softening or clarification without softening, under widely varying conditions of hardness, turbidity and water temperature.

The Omaha plant is on the west bank of the Missouri River, from which it draws its supply of raw water through two intakes at the north end of the plant. Low service pumps lift raw water through two 60-in. pipes to three new preliminary settling basins at the south end of the plant. Settled water then flows northward through an "around-the-end" baffled chlorine mixing basin, and into an old basin converted for chlorine contact, from which it is discharged to the solids-contact units. The effluent from these units flows through a large settling basin, another "around-the end" baffled mixing basin, and two large final settling basins before it reaches the filters.

Why solids contact?

The Omaha plant dates from 1889. Until the recent improvement program was carried out, no mechanical mixing, flocculating or sludge-removal equipment was provided, and the nominal plant capacity was about 72 mgd. As additional capacity became necessary, studies indicated that expansion to about 140 mgd should be undertaken, and that modern mechanical equipment must be provided. Existing basins were not suitable for the installation of such equipment. It was therefore determined to remove two of the existing basins (of 7 million gal each) and use the space for four new basins with solids-contact equipment. Existing basin No. 6, now used for chlorine contact, and the new preliminary settling basins, tend to iron out fluctuations in the quality of the water applied to the solids-contact units. Existing basins following the units are available as buffers in the event of an upset.

The old plant had been capable of

The new plant at Omaha

RICHARD O. DAVIS, F. ASCE, Associate, Burns & McDonnell Engineering Company, Kansas City, Mo.

clarification only, and it was anticipated that this procedure would continue temporarily with the new plant. However, it was expected that softening would be undertaken in the future. The excellent chemical efficiency offered by solids-contact equipment, especially during softening, was considered. Also, economic comparisons showed a lower capital investment for solids-contact units than would be required for any comparable conventional layout.

Operating requirements

At the time the plant improvments were designed, records indicated that Missouri River water varied as follows:

Turbidity	10.0 to 15,000 ppm
Total alkalinity, as $CaCO_3$	100 to 250 ppm
Non-carbonate hardness, as $CaCO_3$	40 to 175 ppm
Total hardness, as $CaCO_3$	150 to 375 ppm
pH	7.5 to 8.4
Temperature	32 deg F to 85 deg F

New upstream reservoirs now in operation are reducing peak variations in turbidity and hardness.

Operating requirements specified for each of the four solids-contact units were as follows:

1. Rates should be from 3 to 35 mgd in summer and from 3 to 20 mgd in winter.
2. During clarification, effluent turbidity could not exceed 10 ppm with influent turbidities up to 4,000 ppm.
3. During softening, alkalinity had to be reduced to 35 to 40 ppm and total hardness to 80 to 100 ppm of equivalent calcium carbonate.
4. Sludge required such concentration that not more than 2 percent of the influent flow of water would be required for sludge withdrawal.
5. Units had to be capable of starting up with the basin empty and providing an effluent meeting the specified requirements at the maximum flow rate in less than 8 hours.

The contractor was required to guarantee that such operating results could be obtained with chemical solution dosages not to exceed those required by the laboratory jar-test stirring technique with previously formed slurry at equal water temperature, and that residual turbidity in the basin effluent would be filterable to less than 0.5 ppm through the plant filters. Table I summarizes the data on the solids-contact units.

Flow controls and problems

Influent conduits are arranged to permit any selected part of the plant flow to be bypassed beyond the solids-contact units. Such an operation is sometimes desirable for split treatment during softening. Control of flow in the bypass is effected from a remote location in the chemical building by means of signals from a propeller-type meter and a pneumatically operated butterfly valve.

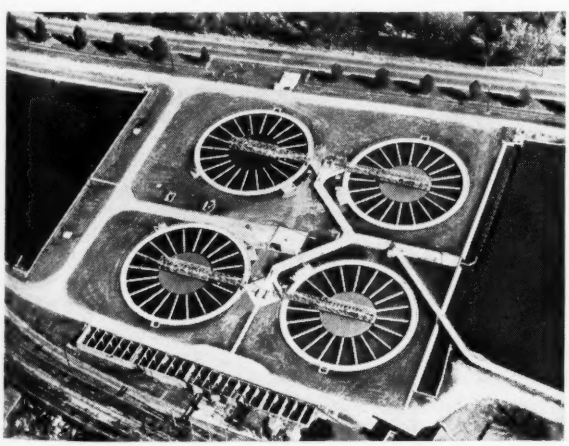
TABLE I. Solids-contact units

Manufacturer	Infilco, Inc.
Basin diameter	120 ft
Water depth	± 26 ft
Launder length	940 ft
Rise rate	0.35 fpm or 2.6 gpm per sq ft at 35 mgd
Impeller diameter	30 ft
Drive	40-hp U.S. Varidrive
Influent pipe	48 in.
Retention time	75 min at 35 mgd

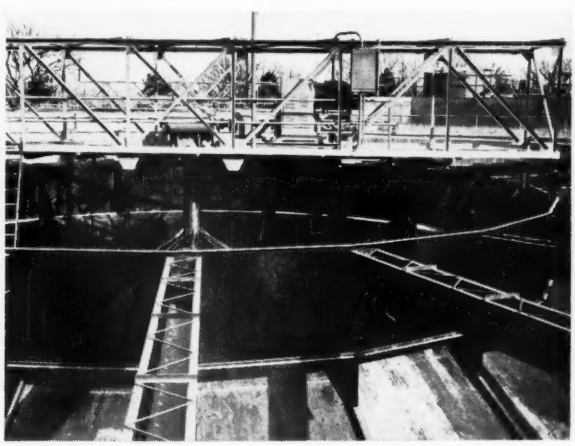
Water not bypassed is divided equally through conduits to each pair of solids-contact basins, where it again is divided equally through a 48-in. pipe to each unit. Effluent is discharged through a 48-in. pipe to a common conduit together with bypassed water. Effluent may also be discharged into bypasses on either the east or the west side when it is desirable to remove the regular conduit from service.

The high rates of flow treated in these units require that rise rates be maintained very nearly uniform over the entire area. To accomplish this, each unit is equipped with 20 radial launders and a peripheral launder, all provided with orifices.

Butterfly valves regulating the flow to each unit are mounted on the submerged 48-in. influent pipes projecting into uncovered chambers. Orig-



Four solids-contact units installed at the Omaha water treatment plant provided an increase in capacity from 72 to 140 mgd. This installation permits the introduction of water softening through the solids-contact process.



A 40-hp U.S. Varidrive motor supplies power for the operation of the solids-contact units. Walkway bridge over one of the primary basins seen here provides support for the Varidrive, reducer, and impeller.

inally the propeller-type meters were installed about 10 ft downstream from the valves with straightening vanes between. However, with this arrangement false readings were obtained from the meters with the valves in a throttling position, because of the unequal distribution of flow across the pipe cross-section. In retrospect, it seems obvious that this would be the case, since the throttled valve presents a larger opening on one side, where the vane extends into the chamber, than on the other side, where the vane projects inside the pipe. In this case the straightening vanes, instead of suppressing turbulence, simply channeled the unequal flows directly to the meters.

Corrective measures consisted of installing a short flange-to-spigot piece on the exposed flange of each valve, as well as changing the location of each meter to a point within the basin as far downstream from the valve as possible. As a result overall accuracies of 3 to 5 percent were obtained.

It was found that orifice spacing was too close at the junctures of the radial launders with the peripheral launder, causing excessive rise rates and "thunderheads" in these areas. The problem was easily solved by simply plugging some of the peripheral orifices adjacent to the radial launders. Also, in two of the basins, unequal collection was obtained during low rates of flow because these basins had tilted slightly through unequal settlement. The difficulty was caused by the fact that the orifices were not submerged during low flows and functioned as would serrated weirs that are not level. This problem was overcome by installing a straight weir in the collecting peripheral launder ahead of the effluent discharge chamber. In this manner the water level in all launders is maintained high enough to submerge the orifices and thus provide satisfactorily uniform collection. The weir is about 30 ft long, and thus regulates the water level within close limits during all rates of flow.

Each solids-contact unit is equipped with seven sludge concentrating compartments. The sludge is withdrawn from each compartment by gravity through a quick-opening, pneumatically operated valve which is electrically timed for intermittent operation. Controls are provided for manual adjustment, in the blowoff sump, of both the time interval between valve openings and the length of time the valve remains open. Controls are also provided in the chemical building for remote adjustment of the timing cycle on each basin. Sludge withdrawal pipes are equipped with fittings for high-pressure water connections in case back flushing is ever necessary.

Concentrated sludge collected from the units flows by gravity to a sludge-pump structure whence it can be pumped to the preliminary settling basins or the final mixing basin, or drained directly to the river. No difficulty is experienced in handling sludge concentrated up to a solids content of about 5 percent.

Chemical feed

Facilities are provided to supply the solids-contact units with alum or ferric sulfate, activated silica, activated carbon, lime, and soda ash at controlled rates, which are indicated and recorded at the chemical building. Results of treatment can be closely watched by means of sampling lines from various points ahead, within, and behind the solids-contact units. However, a certain number of "grab samples" are still found necessary. Facilities also include automatic measuring and recording instruments for pH and turbidity; however, automatic, continuous-flow turbidimeters have not proved satisfactory and are no longer used.

The plant is designed to divide the flow of water equally among the solids-contact units for treatment, even with a unit out of service. Chemical-feed facilities are also provided to maintain an equal distribution of feed to each operating unit. All chemical feed is by gravity through dual hose lines, accessible for maintenance throughout their length of about 900 ft in concrete conduits provided with removable covers. All hose lines are equipped with high-pressure water connections for flushing. The lime-solution lines are also provided with compressed-air connections.

Omaha lies in a latitude where ice sometimes becomes 30 in. thick or more but the investment required to completely enclose the basins has been avoided by the adoption of other measures for ice control. Experience has shown that a solid sheet of ice on the surface of the basins does not prevent effective treatment. However, the formation of ice on weirs and in launders can cause a great deal of interference with the collecting system. To prevent this difficulty, the engineers used protective devices consisting of covers over the launders, which project a few inches beyond the weir to support a flexible metal skirt extending below the water surface. Ice on the basin surface ends at the skirt, and the water behind the skirt and under the cover remains free of ice. Basin effluent water flows under the skirt and rises to the weirs or orifices. Such covers also appear useful in eliminating sunlight and thus preventing formations of algae in the clear water carried in the launders.

Each of the four units was tested separately for clarification without softening under winter conditions when the water temperature was below 35 deg F, and again under summer conditions when it was above 65 deg F. The testing procedure in both cases was as follows:

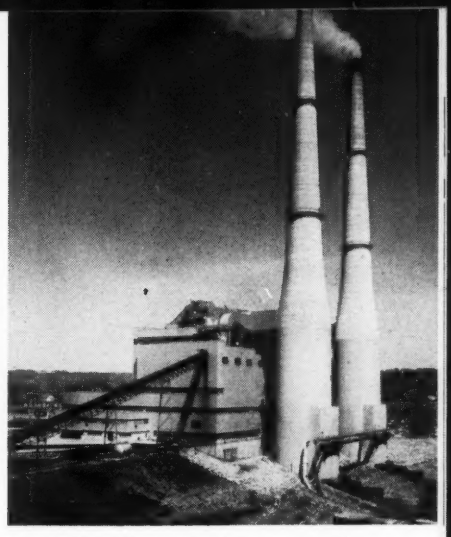
1. Units were drained dry and thoroughly cleaned.
2. Samples of water to be treated were obtained from the influent conduit and tested for coagulant requirements.
3. Starting with the basin empty, the equipment was started and water and chemicals applied according to the contractor's instructions. Units were filled and the rate of flow increased as rapidly as possible to the greatest maximum flow that would furnish effluent water of the specified quality.
4. Units were then operated continuously for over 72 hours at the specified maximum flow rate, and continuous records were made of rate of flow, rates of chemical feed, and rate of blowoff water used.

Samples of influent water, effluent water, and blown-off sludge were collected and tested every four hours. Calculations made to determine the efficiency of the equipment compared with the specified requirements were based on the total quantity of water entering the unit, the total weight of chemicals used, and the total quantity of water blown off during the 72 or more hours of continuous operation.

Samples of influent water were tested to determine the quantities of various chemicals that should be required. Jar tests were in general conducted in 1-liter beakers at the water temperature prevailing in the basins, with a 5-min stirring period, not less than three sludge returns, and a settling time compatible with the rise velocity in the treatment unit and the sample depth. The opimum chemical dosage was selected as that which would produce a 5-ppm turbidity in the supernatant liquid under these conditions as determined by the Hellige turbidimeter. The tolerances allowed for accuracy were 5 percent in the laboratory tests, 3 percent in the flow-meter readings, and 1 percent for the chemical-feed machine. Infilco, Inc., the contractor, surpassed all test requirements.

(This paper is based on Mr. Davis's paper presented at the ASCE Boston Convention, before a session of the Sanitary Engineering Division.)

Second chimney is under construction while first chimney nears completion. Scaffolding for construction can be seen extending above second chimney.



New Albany Power Station near Louisville, Ky., with both chimneys completed.

Big chimneys create big problems

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Control of air pollution becomes increasingly important in our economy as our industrial plant increases. The electrical utilities are aware of this problem and for many years have placed great emphasis on reducing the amount of air pollution contributed by power plants. Their efforts have resulted in improved dust-collection equipment and increased stack heights to disperse the gases over a greater area to achieve better dilution. Within the past ten years, this trend has produced stack heights of 500 to 700 ft, far exceeding previous ones. Such stack heights present many problems for the structural engineer.

The economical limit in height for steel stacks supported on a boiler-room roof is approximately 200 to 250 ft above roof level. As this height was exceeded, engineers turned to concrete chimneys as the logical answer. Throughout the country many of these concrete giants were built, reaching gracefully towards the sky and creating new landmarks.

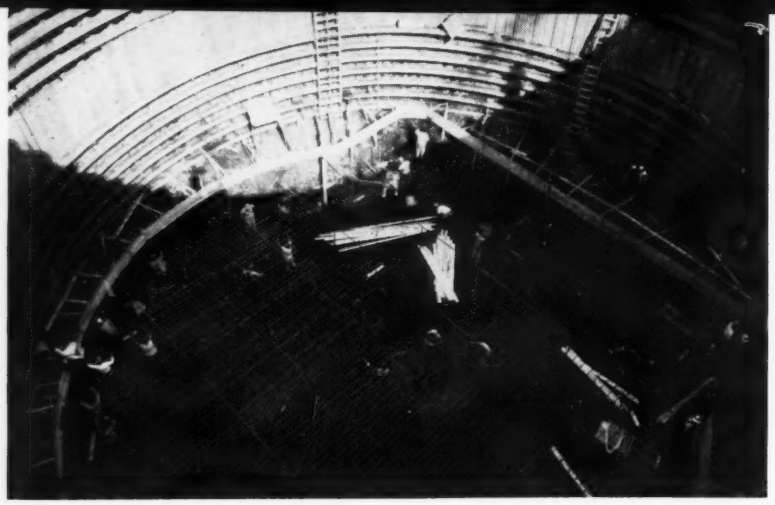
As these stacks rose higher and higher, so also did the cost of constructing them. The cost of some of the larger stacks has approached half a million dollars. Obviously it is important to obtain maximum utilization of such expensive structures. Since in many power-plant designs the gas duct enters the chimney approximately 150 ft above grade, the lower part of the chimney serves merely as a supporting structure for the upper part. Engineers soon realized that a substantial saving could be realized by utilizing this lower space to house auxiliary equipment, and the multipurpose chimney was born.

The two huge chimneys at the New Albany Power Station of the Public Service Company of Indiana, Inc., probably represent the ultimate in utilization of this space. In any case these chimneys probably contain more important power-plant equipment than any other multipurpose chimney built to date.

The New Albany Power Station is on the west bank of the Ohio River across from Louisville, Ky. It was constructed on a rather restricted site created by filling low-lying farm lands to bring the plant area above flood levels. Because of the proximity of the plant to both Louisville, Ky., and New Albany, Ind., and the presence of a surrounding range of hills, high chimneys were considered advisable. Model studies indicated that a chimney height of 550 ft would give adequate dispersal. The best power-plant arrangement provided ducts entering each chimney at a point 130 ft above grade, leaving the lower part of the chimneys available to house equipment.

Foundations

Foundation conditions in this ancient river channel are poor. The soils above bedrock are loose alluvial sands interspersed with meandering beds of compressible silts overlain by soft clays and silts. The only suitable founding material for a heavy chimney was found to be a very hard calcareous shale which occurs 90 ft below the surface of the ground on this bank of the river. A tall chimney was required for each group of two units in the four-unit installation. For the same two units it was necessary to build a water intake crib 68 ft in diameter from grade down to rock in order to reach water at normal pool levels for the Ohio River. Since in each case the foundation for the chimney and the intake crib had to go down to rock, it was a logical step to consolidate the two structures and flare the base of the chimney so that it could be placed on top of the intake crib. In the final design the equipment listed in Table I was placed in the combined crib house



Construction of base slab for combined crib and chimney base is seen under way in view looking down into the cofferdam.

and chimney base for the first chimney. Similar equipment was installed in the second chimney and crib-house structure except that some of the water treating equipment was omitted.

Construction of these chimneys and their substructures was divided between the power-plant substructure contractor, the Gust K. Newberg Construction Company, and the chimney contractor, the Custodis Construction Company. Newberg drove sheetpiling to form a circular cofferdam, which was braced by rings formed of wide-flange beams, leaving the working area free of cross bracing. The crib house was then constructed to a point 40 ft above the plant grade, at which point Custodis began construction of the chimney. A steel-framed scaffolding rig approximately 30 ft high, with outriggers to hold the metal forms, was utilized for chimney construction.

The shell of both chimneys was poured in 7.5-ft lifts and anchors were embedded in the inside face of the concrete to provide supports from which the scaffolding rig was hung. This rig was raised as construction progressed by attaching cables to anchors placed in more recent pours and hoisting the rig to the new elevation by its own boot straps. Concrete in a bucket was hoisted up the center of the shaft to the scaffolding. In the case of the first chimney, construction of the crib house took 6 months and construction of the chimney itself, interior floors and brick lining, required 14 months. The second chimney required a similar time but encountered a delay between the completion of the shell and the installation of the lining.

The first chimney was designed in accordance with the pattern accepted at that time for tall chimneys. The shell was cast with shelves or corbels encircling the interior of the chimney at 37-ft intervals to support a single thickness of brick lining. The space between the brick lining and the shell was filled with spun-glass insulation.

This type of design has been used for many power-plant chimneys during the past eight to ten years, since the cost is so much lower than that for chimneys with independent brick linings. In a tall chimney, an independent brick lining requires a very thick base to support the weight of the brick above.

Second chimney not insulated

The second chimney was designed on the same basis as the first and the shell had been completed when the utility industry became aware that chimneys of this design throughout the country were becoming streaked with moisture seeping out from the inside through the shell. Investigations showed that the gases containing SO_2 and SO_3 were penetrating the insulation space and condensing to form sulphuric acid, which was attacking the insulation and the concrete. It appears that this action is accelerated by the positive gas pressure existing in the chimneys of most modern power plants. It was obvious that the brick lining could not be made tight enough to keep these gases from penetrating the space between the lining and the shell.

Numerous studies were initiated to determine whether some alternative type of lining construction would afford better protection. Table II shows the estimated cost of various other schemes developed as possible solutions for the second chimney. It soon became obvious that these solutions made the lining cost almost as much as the shell it was intended to protect. Of all the schemes, the insulated steel liner seemed to offer the best possibilities but was however very expensive.

While it was assumed that the steel liner would be reasonably trouble free during the period when the station was new and used as a base-load station, it was logical to consider the possibility of extensive corrosion when the station became older and was used more for peaking purposes, since the opportunity for the formation of condensation increases drastically under these conditions. Since this chimney serves two units, repairs would require the shutting down of both units, thus cutting the capacity of the station in half.

After months of study, two conclusions were arrived at. First, a major source of difficulty is the type of insulation, which acts as a sponge in collecting the acid liquid and holding it against the shell. Second, a major additional investment in an unproven lining system could not be justified at this time, since in spite of numerous reports of chimneys seeping acid, some of these chimneys had been in operation for five years with no maintenance expenditure required. It was agreed that if a scheme could be developed to avoid this additional initial investment, the saving in carrying charges on this money would more

TABLE I. Equipment housed in combined chimney and crib-house structure for Units 1 and 2

1. **Crib-house area**
   - Four traveling screens
   - Trash rake
   - Log gates
   - Four circulating pumps
   - Four service pumps
2. **Water treatment plant area**
   - One 550-gpm water clarifier and accessories
   - Three 200-gpm anthracite filters
   - Four cation and anion exchangers
   - One degasifier and catchment tank and pumps
   - One acid tank and one caustic tank and pumps
   - One set of drinking-water filters
   - Two lubricating-water pumps
   - One polishing demineralizer and acid and caustic tanks
   - One 12,000-gal caustic storage tank
   - Two 100,000-gal demineralized-water tanks
   - One chemical storage bin and feed hopper
   - One 55,000-cfm heating and ventilating unit
3. **Elevator**

TABLE II. Costs of various schemes for linings

	Type	Cost
1.	Original brick and spun-glass insulated lining	$ 97,500
2.	Brick lining with insulation encapsulated and shell coated with mastic	$188,500
3.	Substitution of fused silica insulation behind brick	$250,500
4.	Independent concrete liner	$135,000
5.	Independent steel liner with spun-glass insulation	$165,000

than justify later expenditures for the maintenance of the shell. It was therefore decided to omit the insulation and accept a slightly higher but still reasonable thermal stress on the concrete shell. The insulation space was left void and an additional mastic coating was placed on the shell.

The first chimney, which was placed in service in November 1958, is beginning to show some signs of acid leakage. It is considered probable that some work will eventually be necessary to correct this condition, but no major expenditure is anticipated for many years. The repair work may take the form of a new lining or coating on the existing lining or some measure such as pumping a compressible acid-resistant material into the space between the shell and the present lining. Another measure that may be considered is pressurizing the air space to keep out the sulphur-laden gases.

The second chimney has been in operation with half of its ultimate load since March 1960. No signs of seepage have been noted up to the present time, but a good test will not be developed until more time has elapsed with full load on the chimney. The chimney will be watched closely to determine if the acid attack will be less than that experienced in the first chimney.

Future design possibilities

It is interesting to speculate where chimney designers will turn in the future. Fused-silica insulating blocks show great possibilities for use in place of the brick lining, but their cost is too high at present. There is at present a strong trend throughout the country toward the use of insulated steel liners in chimneys now being constructed. The first of these will go into service in the near future, but some time will be required to properly evaluate the performance. Concrete liners are advocated by some chimney builders and offer interesting possibilities.

Unlined concrete stacks fell into disrepute in the 1930's because so many were built under early design codes that provided insufficient reinforcing for thermal stresses, with the result that the chimneys cracked badly. The present code is an improvement, and one utility has had considerable success with unlined chimneys constructed under it. Further strengthening of the code would probably produce chimney designs that would be relatively crack-free. If such a code can be produced, the way will be open for an inexpensive chimney that will probably not require a great deal more maintenance than other types. The cost of such an unlined shell is very low and would offer major savings, which would make it of considerable interest to any utility that analyzes its capital investments on the basis of present worth, even allowing for considerable future maintenance.

If improvements are to be made in chimney building, the American Concrete Institute Code 505-54, which governs chimney design, must be improved. The code was a great step forward at the time it was written, but it contains some flaws. An ACI committee is now reviewing the code and it is the writer's hope that many improvements in the design theory can be incorporated in the code.

Illogical code assumptions

The present code is based on the assumption that the hot inner section of the shell is restrained from expanding fully by the action of stretching the reinforcing steel to the amount represented by the normal thermal expansion of a "neutral surface," which is further assumed to lie at the border between the net compressive zone and the net tensile zone. It is further developed by equations incorporating several other assumptions that the location of this neutral surface is determined primarily by the amount of reinforcing steel. Straight-line variation for the stress pattern is assumed and rigid limits are placed on the allowable stresses. Stresses are considered in the vertical and circumferential directions only; no consideration is given to radial stresses.

This arrangement offers no obstacle to the design of thin walls for relatively high temperatures. However, as the thickness of the wall increases, the total compressive stress increases and thereby increases the stress on the reinforcing steel. Increasing the area of the reinforcing steel reduces the net amount of stretch developed in the steel and tends to shift the neutral zone to the right in Fig. 1, which in turn increases the compressive stress. With the present arrangement of allowable stresses, this method soon reaches the point where allowable compressive stresses are exceeded.

The present provisions are illogical in that they provide on one hand a theoretical solution to the stress problem by moving the steel closer to the neutral axis, and on the other hand make the problem somewhat absurd by adjusting the compressive stress with variations in steel areas and holding the compressive stress to definite limits. No record seems to exist of any failures due to thermal compressive stresses, and it seems logical to question whether or not the present limits are justified.

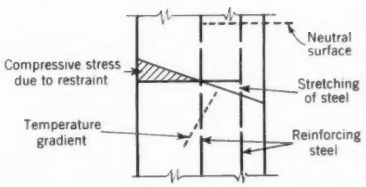


FIG. 1. Straight-line variation of the stress pattern is assumed in the present chimney code, and rigid limits are placed on the allowable stresses. Stresses are considered to be in the vertical and circumferential directions only; no radial stresses are assumed to occur.

A major point not covered by this theory, however, is the existence of a radial stress—which may be thought of as a radial thrust—which must be taken into the hoop tension in a concrete chimney. Integrating this across the face of the chimney yields a total radial stress that is approximately one-tenth of the total tensile or compressive forces. Since this acts similar to a bursting pressure, it must be so treated across the diameter of the shell. Hence the total hoop stress due to this may be larger than the hoop tension caused by the circumferential temperature stress.

This latter point needs considerably more study. It appears not to have been too important recently because insulated chimneys have probably reduced temperature gradients more than was assumed in their design. It would be very important, however, in an unlined chimney, and it is probably one reason why so many failures were experienced with them.

Another area that has not been covered adequately is the subject of discontinuity stresses at the top of the chimney. The vertical tension and compression forces act as an unbalanced couple resisted by the continuous ring action of the shell. Near the top, however, the effect of the discontinuity of the upper edge is felt and has not been considered in the present code. This is probably one reason why many chimneys have vertical cracks beginning at the top. It is understood that the ACI committee studying the chimney code is planning to increase reinforcing requirements at this point.

It can be expected that design and construction practices for concrete chimneys will change radically in the next few years. This article has mentioned briefly some of the problems that need attention. It is hoped that the efforts now being made to solve some of these problems will make it possible to build chimneys that will be both inexpensive and trouble-free.

Drafting-room problems solved by analytic geometry

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Both students and instructors often lose sight of the fact that the content of elementary engineering courses has many practical applications in solving problems encountered in the drafting room and the design office. More emphasis on these practical applications will tend to increase the student's interest in these subjects. The successful completion of subjects by undergraduates should mean more to them than merely a key to a diploma. I wish here to show how one subject, analytic geometry, can be a very valuable tool to the engineer. With the use of a desk calculating machine, its value is increased many fold.

A few relationships most frequently used in solving practical problems by means of analytic geometry are:

1. The equation of any straight line,

$$y = mx + b \quad \ldots\ldots (1)$$

2. The equation of a circle whose center is the origin,

$$x^2 + y^2 = r^2 \quad \ldots\ldots (2$$

3. The equation of a circle whose center is the point h, k,

$$(x - h)^2 + (y - k)^2 = r^2 \ldots (3)$$

4. The angle between any two lines or the angle through which Line 1 must be rotated in the counterclockwise direction to coincide with Line 2,

$$\tan \phi = \frac{m_2 - m_1}{1 + m_1 m_2} \quad \ldots (4)$$

The trigonometric form of Eq. 4 is

$$\tan (a \pm b) = \frac{(\tan a \pm \tan b)}{(1 \mp \tan a \tan b)} \ldots (4a)$$

where tan (a $\pm$ b) is equal to tan ϕ.

These formulas and their derivations can be found in any standard text on analytic geometry, such as *Analytic Geometry*, by Love and Rainville (Macmillan Co., 5th ed.).

Angle between two members

In office practice it is often necessary to find the angle between two members. This can be easily done by employing the principles of analytic geometry. A typical brace found in many structures is shown in Fig. 1. The problem is to obtain the slope of the working line of one of the angles with respect to the working line of the other angle. This is useful when laying out the gusset plate. When the distance between the working points is known, it is easy to find the slope of each brace, keeping in mind that slopes of lines rising to the right are positive and those rising to the left are negative. Then m_1 is equal to (9.50)/(6.75) or 1.4074, and m_2 is equal to −1.4074. Substituting these values in Eq. 4, tan ϕ is equal to 2.8699. The slope of Line 1 with respect to Line 2 is 4.1813 in 12, or 4 3/16 in 12 (to the closest 1/16th).

The elevation of an end floor-beam bracket from an actual through-plate-girder railroad bridge is shown in Fig. 2. It was required to determine the slope of the bracket when checking the shop details in the office. The solution to this problem also involves the use of Eq. 4. In this case, ϕ and m_2 are known and m_1 is the slope required. The slope of Line 2, m_2, is (−30.7500)/(16.5625), or −1.8566.

The length of Line 1 is

$$\sqrt{(30.75)^2 + (16.5625)^2 - (4.75)^2}$$

or 34.6023 in. Tan ϕ from Fig. 2 is (4.750)/(34.6023), or 0.1373. From Eq. 4, taking into account the signs of the slopes, 0.1373 is equal to

$$\frac{-1.8566 - m_1}{1 - 1.8566\, m_1}$$

or m_1 is equal to 2.6760. The slope of Line 1 is then 4.4843 in 12 or 4½ in 12 to the closest 1/16th.

This problem could also be solved by using Eq. 4(a) for the tangent of the sum of two angles, tan (a + b) being the slope of Line 1. In any case, it should be noted that it was not necessary to solve for any angles. In general, the use of analytic geometry will hold the use of trigonometric tables to a minimum, as here shown.

An alignment problem

A plan view of an actual railroad alignment problem is given in Fig. 3. Here a curved railroad track intersects a street that is also on a curve. To obtain a sight distance from the street, the municipality required that Pier 3 be so located that the length of a line

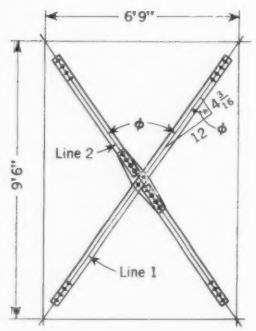


FIG. 1. Typical brace, found in many structures, presents the problem of obtaining the slope of the working line of one angle with respect to that of the working line of the other angle.

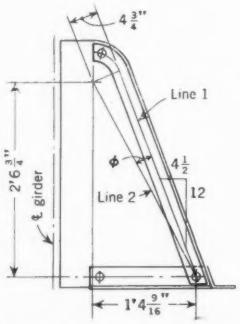


FIG. 2. Elevation of an end floor-beam bracket from an actual through-plate-girder railroad bridge is shown. It was required to determine the slope of the bracket when checking shop details.

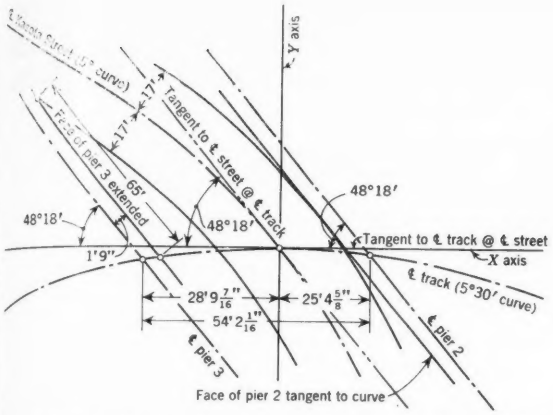


FIG. 3. A curved railroad track intersects a street that is also on a curve. To provide sight distance from the street, Pier 3 had to be located so that the length of the line intercepted by the center line of track and edge of pavement, and lying in the plane of the face of Pier 3, should be 65 ft long.

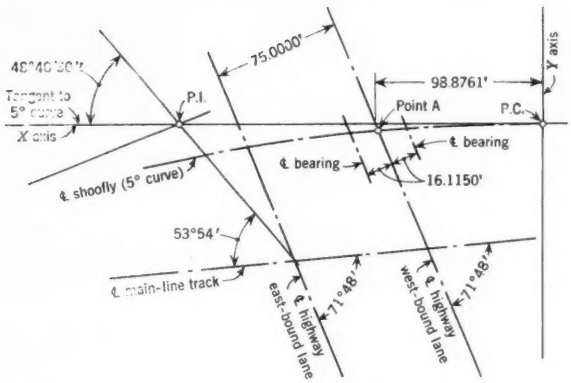


FIG. 4. A shoofly was constructed so that both rail and highway traffic (on both lanes) could be maintained during construction of a grade separation. Openings in shoofly for highway traffic were spanned with steel beams on timber pile bents, and it was necessary to determine the angle of skew for the different spans. A minimum highway clearance was required.

intercepted by the center line of track and edge of pavement, and lying in the plane of the face of Pier 3, be 65 ft long.

This problem can be solved very easily by the application of the principles of analytic geometry. One of the advantages of the use of analytic geometry is that the problem can be reduced to rectangular coordinates. That is, once an axis is chosen and the equations of the various curves and straight lines are obtained, the coordinates of any point of intersection or any angle are available at once.

For the problem shown in Fig. 3, the coordinate axis was chosen in such a manner as to make the X-X axis tangent to the center line of the track, and the Y-Y axis was chosen to coincide with a radius of the center line of the track and to pass through the point made by the intersection of the center line of the street and the track.

The angle between the tangent to the center line of the track and the tangent to the center line of the street was measured in the field and found to be 48° 18′. As the radius of a 5° 30′ curve is 1042.1415 ft, the center of the circle representing the center line of the track is at (0, −1042.1415), and from Eq. 3, the equation of the center line of the track is

$$x^2 + y^2 + 2084.2830\,y = 0 \quad . \quad (5)$$

The center of the circle representing the center line of the street is at (−855.8558, −762.5397) and has a radius of 1146.2792 ft. The equation of the edge of the pavement having a radius 17 ft less than that of the center line of the street and the same center, is found from Eq. 3 to be

$$x^2 + 1711.7116\,x + y^2 + 1525.0794\,y + 38{,}684.4329 = 0 \quad . \quad . \quad . \quad (6)$$

Calling the coordinates of the point of intersection of the line representing the extended face of Pier 3 with the center line of the track $(-a, -b)$, the coordinates of the point of intersection of this line with the edge of the pavement then become

$$-a - (65 \cos 48° 18') \text{ and } (65 \sin 48° 18') - b$$

Substituting these coordinates in Eq. 6 results in the equation,

$$b = 3.5167\,a - 92.8493 \quad . \quad . \quad (7)$$

Substituting in Eq. 5 the value of $-a$ for x, and the value of $-b$ as obtained from Eq. 7 for y, gives a equal to −26.4982. Substituting this value in Eq. 7 gives b equal to −0.3369, the values of both a and b being negative. The equations of the center lines of Pier 2 and Pier 3 work out to be

$$y = -1.1224\,x + 28.1857 \quad . \quad (8)$$
$$y = -1.1224\,x - 32.7092 \quad . \quad (9)$$

respectively. Using Eqs. 5, 8, and 9, the distance from center to center of piers is obtained. Just enough of the solution for this problem is given here to indicate the flexibility of this method of attack.

Determining angles of skew

Part of the alignment for a shoofly constructed recently to enable a state highway grade separation to be built while maintaining railroad traffic is given in Fig. 4. Rather than detour highway traffic during the construction of this grade separation, this particular state highway department required that both east-bound and west-bound lanes remain open to vehicular traffic. This meant constructing a number of openings in the curved part of the shoofly to permit passage of highway traffic. The openings were to be spanned with steel beams supported on timber pile bents, and it was necessary to determine the angle of skew for the different spans. A minimum highway clearance was required as part of the design criteria; therefore, for any given span length in the curved part of the shoofly, it was necessary to check the horizontal clearance.

Again, a convenient coordinate axis was chosen, as shown in Fig. 4, and the problem resolved itself into one of finding the required coordinates of points and the required angles of lines. From field measurements and trigonometry, it was found that the center line of the west-bound lane of the highway intersected the X-X axis at −98.8761 ft from the center of coordinates. Substituting this value for $-x$ and the tan 66° 34′ 30″ for the slope in Eq. 1, gives for the equation of the center line of the west-bound lane of the highway,

$$y = -2.3081\,x - 228.2159 \quad (10)$$

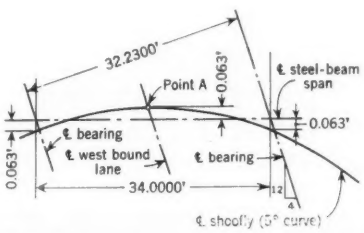


FIG. 5. An enlarged section of Fig. 4 shows the general arrangement of the curve and the steel-beam span.

With its center on the Y-Y axis at y equal to -1146.2792, and using Eq. 3, the equation of the center line of the shoofly becomes

$$x^2 + (y + 1146.2792)^2 = (1146.2792)^2 \quad \ldots . \quad (11)$$

By solving Eqs. 10 and 11 simultaneously, the coordinates of point A are obtained. For this point of intersection of the center line of the west-bound lane and the center line of the shoofly, x equals -97.0915 and y equals -4.1193. The center line of the steel span is to be placed parallel to and 0.063 ft from the tangent to the center line of the shoofly at point A. It is then required to find the angle between this tangent and the center line of the west-bound lane of the highway because the pile-bent supports for the steel span will be driven parallel to the center line of the highway.

Resorting to elementary calculus, the first derivative of Eq. 11, the equation of the center line of the shoofly, works out to be

$$\frac{dy}{dx} = \frac{-2x}{2y + 2292.5584} \quad \ldots . \quad (12)$$

This Eq. 12 gives the slope of the center line of the shoofly at any point. By substituting in it the coordinates of point A as found above, the slope of the shoofly at point A, and consequently the slope of the tangent to the shoofly at point A, is found to be 0.0850.

The slope of the center line of the highway with respect to the coordinate axis is given as $-\tan 66° 34' 30''$. Using either Eq. 4, taking m_1 equal to -2.3081 and m_2 equal to 0.0850, or Eq. 4(a) for the tangent of the sum of two angles, the tangent of the angle between the center line of the steel-beam span and the center line of the west-bound lane becomes 2.9772. This is equivalent to a slope of 4 in 12 to the closest 1/16th with respect to the center line of the steel span.

Knowing the tangent of the angle between the center line of the steel-beam span and the center line of the west-bound lane makes it possible to calculate the distance center to center of bearings normal to the center line of the highway, and therefore the clearance, by the use of similar triangles. This amounts to

$$\frac{34 \times 2.9772}{3.1407} = 32.2300$$

Again it should be noted that once the equations of the lines and curves are known, any angle or distance can be readily computed. An enlarged portion of Fig. 4 is given in Fig. 5, which shows the general arrangement of the curve and the steel-beam span.

ENGINEERS' NOTEBOOK

Spacing of shear connectors for composite sections

LES N. FRANCIS, M. ASCE, Supervisory Engineer
Bridge Division, Department of Highways, Ontario, Canada

The task of spacing shear stud connectors on composite steel-concrete sections can be greatly facilitated by the use of ready-made charts such as Fig. 1, on which is plotted the KV curve. By projecting horizontal lines from any selected pitch scale (shown on the right-hand side of the chart), various points along the span where the spacing can be changed are readily seen.

Notation

S = horizontal shear at junction of slab and beam
= KV where $K = m/I$; also
= $\frac{N \times Q_{uc}}{p \times \text{F.S.}}$
V = vertical shear on composite section
m = moment of area of slab (transformed, using $n = E_s/E_c$) about neutral axis
I = inertia of composite section
N = number of studs per row
p = pitch in inches
Q_{uc} = shear stud capacity
F.S. = factor of safety

Example

Determine the spacing of 7/8-in.-diameter studs (4 studs per row) on a girder of 66-ft span carrying the following shears:

K for the composite section = 0.026

	V, Asphalt + L.L.	KV
Support	63 kips	1.638
0.1	54.52 kips	1.418
0.2	46.04 kips	1.197
0.3	37.56 kips	0.977
0.4	29.08 kips	0.756
0.5	20.6 kips	0.536

From Fig. 1 the spacing is found to be as follows:

From	To	Pitch
Support	0.057 L	7½ in.
0.057 L	0.238 L	9 in.
0.238 L	0.34 L	12 in.
0.34 L	0.4 L	15 in.
0.4 L	0.455 L	18 in.
0.455 L	Centerline	21 in.

This method gives the designer an easy-to-read computation and, should he choose to switch to a different stud diameter at any point along the span, he has only to project lines horizontally from the respective pitch scale in question.

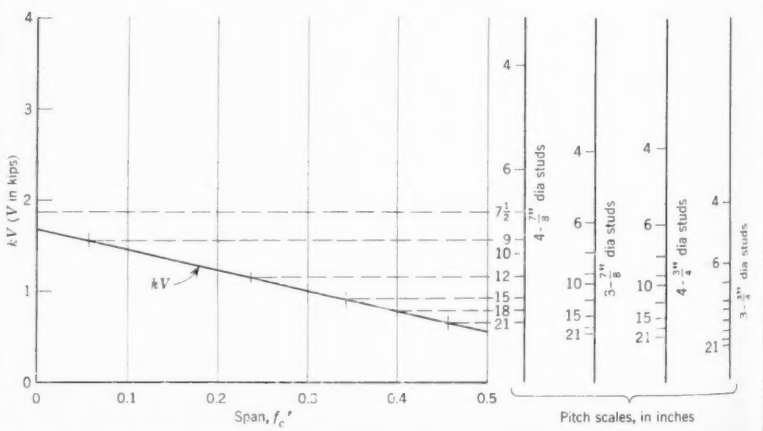


FIG. 1. Chart gives spacing of shear connectors for composite sections, assuming f_c'=3,000 psi and F.S.=4.

Details for a 425-ton pile test

JOHN W. FOWLER, M. ASCE, Project Engineer, Tidewater-Raymond-Kiewit (Joint Venture for Chesapeake Bay Bridge-Tunnel), Bayside, Va.

Four concrete piles of 54-in. diameter, with a wall thickness of 5 in., were driven to a depth of 85 ft and load tested to 425 tons for a bridge and causeway to Wallops Island off the Virginia coast. The huge load was put on each pile by a 500-ton jack reacting against a frame held by eight H-piles driven to a depth of 70 ft.

The material penetrated is a gray silty clay to a depth of 40 ft, then a medium sand with clay binder or seams to 65 ft, and fine gray silty sand below 75 ft. See Fig. 1.

The concrete pile was driven in a 120-ft length to provide a pier column for the support of a high bridge. The Raymond-type differential-acting 150 C hammer, with a rated energy of 48,750 ft-lb, was used with a 15,000-lb ram and an 18-in. fall. The pile hole was lightly jetted to El. −60 and jetted to El. −70 during driving. A condensed driving record is given in Fig. 1.

A special cone-shaped driving cap was used for transmitting the hammer blows to the pile top. This same driving cap was utilized to support a 500-ton hydraulic jack against the test frame.

The 14 BP 73 piles, to take the jack reaction, were driven without

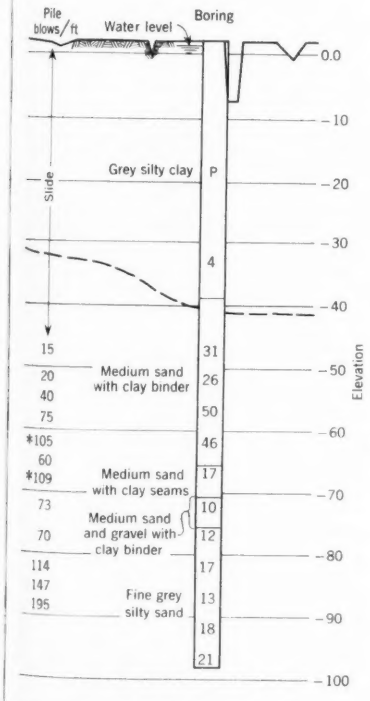


FIG. 1. Concrete piles 54 in. in diameter were driven through silt and sand. Figures under the boring show the number of blows used to force a conventional sampler into the soils; those under the pile are hammer blows on the pile.

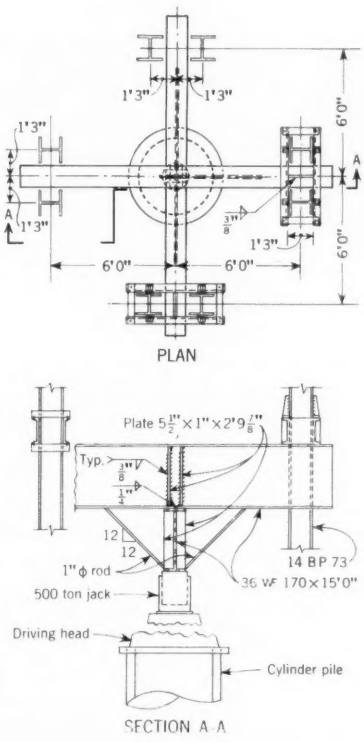
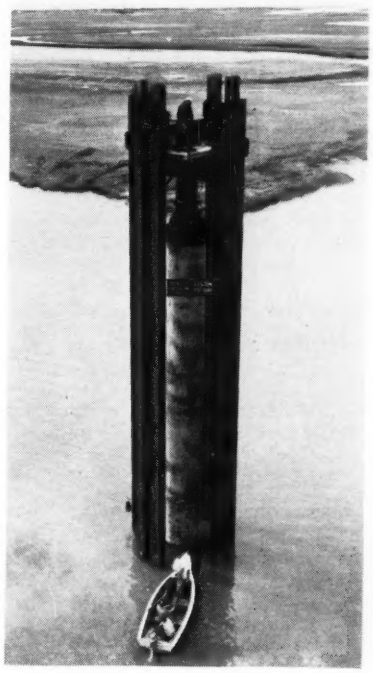
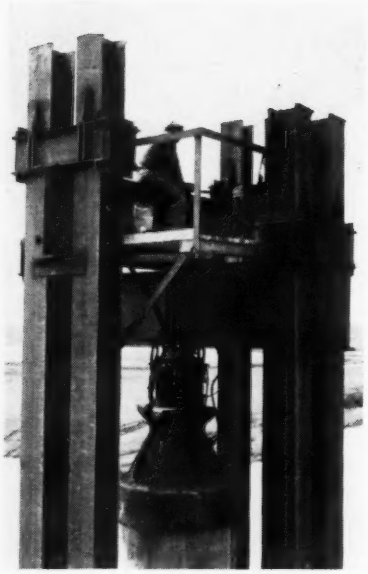


FIG. 2. A frame was specially designed to transfer uplift reaction of jack to H-piles.



Test pile is in position to take 425-ton load. A separate pile, at bow of boat, was used for elevation reference in addition to a survey platform in an adjacent marsh.



The driving cap used on the pile served as the means of applying the test load.

jetting. A unique reaction beam was fabricated complete in the contractor's equipment yard to minimize field labor. The only field welding required was to attach the supporting brackets. See Fig. 2. This was done so that, after the tension piles were driven, the test frame could be set to obtain a solid bearing fit between all structural members. After a test, the supporting brackets are cut free and moved to the next test location.

There appeared to be no pull-up influence on the H-piles as careful checking showed no movement. Also, the second H-pile of a pair was just as hard to pull as the first one.

The test rig was designed by Tidewater Construction Corporation's own engineering department, with the writer as engineer under E. P. Wood, chief engineer. All field operations for this entire project were under the supervision of J. R. Liles, vice president, with L. J. Hartman acting as field superintendent. The bridge and causeway to Wallops Island were designed by the J. E. Greiner Company for the National Aeronautics and Space Administration.

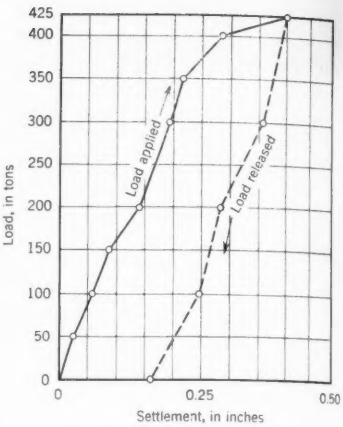


FIG. 3. Results are shown for one of the four piles tested. The test piles became a permanent part of the bridge.

Square and cube roots by calculating machine

S. G. ROEBLAD, F. ASCE, Structural Engineer, George A. Fuller Company, Boston, Mass.

Square roots can be computed directly on an ordinary calculating machine, but I believe it is simpler to use the method outlined below, which arrives at the result by successive approximations.

1. Square root

If N^2 is given and it is required to find N, we can write,

$$N^2 = (A + a)^2 = A^2 + 2Aa + a^2$$

Note that A is a number whose square falls just below N^2, as determined from available tables. If a is a very small quantity, the term a^2 may be neglected and we may write,

$$a = \frac{N^2 - A^2}{2A}$$

The following example will illustrate the method.

Given: $N^2 = 47{,}678{,}907$; find N.

$A = 6{,}900$. $N^2 - A^2 = 47{,}678{,}907 - 47{,}610{,}000 = 68{,}907$.

$$a = \frac{68{,}907}{2 \times 6{,}900} = 4.993$$

$$A + a = 6{,}904.993$$

We now repeat the operation and put $A = 6{,}904.993$

$N^2 - A^2 = 47{,}678{,}907.00 - 47{,}678{,}928.33 = -21.33$

$$a = -\frac{21.33}{2 \times 6{,}904.993} = -0.0015445$$

$A + a = 6{,}904.993 - 0.0015445 = 6{,}904.9914555 = N$

To check,
$(6{,}904.991456)^2 = 47{,}678{,}907.007$

The operation can be repeated as many times as is necessary to get the required accuracy, but two tries are usually sufficient and the number of tries is of course limited by the capacity of the calculating machine.

2. Cube root

Following a similar procedure, we write,

$$N^3 = (A + a)^3 = A^3 + 3A^2a + 3Aa^2 + a^3$$

Neglecting the terms $3Aa^2$ and a^3, we get $a = \dfrac{N^3 - A^3}{3A^2}$

An example follows. Given: $N^3 = 283{,}468{,}976$; find N.
$A = 656$. $A^3 = 430{,}336$. $N^3 - A^3 = 283{,}468{,}976 - 282{,}300{,}416 = 1{,}168{,}560$.

$$a = \frac{1{,}168{,}560}{3 \times 430{,}336} = 0.905$$

$A + a = 656.905$

Put $A = 656.905$ and repeat the operation. $A^3 = 431{,}524.179$.
$N^3 - A^3 = 283{,}468{,}976.000 - 283{,}470{,}390.806 = -1{,}414.806$

$$a = -\frac{1{,}414.806}{3 \times 431{,}524.179} = -0.001093$$

$A + a = 656.905 - 0.001093 = 656.903907 = N$

To check,
$(656.903907)^3 = 283{,}468{,}975.836$

THE READERS WRITE

Head in open-air tube not always constant

To the Editor: In his description of a constant-head device in the August issue, p. 96, Professor Kent does not show the limitations of the apparatus described. The misleading statement is that "As long as the liquid level remains above El. *A* the head remains constant." This is not the case.

Consider an open tube inserted through the sealed top of the tank. [See Fig. 1 in Professor Kent's reply, below.] The pressure initially at the bottom of the tube is the head of liquid h_1. As the liquid is lowered to a distance h_3 above the bottom of the tube, the pressure of the vapor above the liquid is reduced below atmospheric pressure by a head of liquid h_3. Then the pressure at the open end of the tube is $h_2 - h_3$, which may be written as $h_1 - 2h_3$. The pressure at the bottom of the tube is not atmospheric until $h_3 = h_1/2$.

At this point the apparatus will begin functioning as a constant-head device and not before, unless the initial vapor pressure above the liquid is below atmospheric, a condition not stated in Professor Kent's article.

B. W. Sarjeant
Structural Engineer
Read, Jones, Christoffersen
Vancouver, B.C.

Author's reply

To the Editor: Mr. Sarjeant's criticism [above] is partly correct with reference to the statement, "As long as the liquid level remains above El. *A*, the head remains constant. The head *H* is measured between El. *A* and the discharge opening below." This is true provided we allow for a brief time lag, as was mentioned later in the article.

The article written for the Engineers' Notebook is meant to be brief. The method for filling and other precautionary measures have been omitted. To insure the best working conditions for the apparatus, the following should be added:

The best way of filling the tank will be to raise the tube to its highest position and force liquid into the tank from a valve attached to the tank until liquid appears in the tube.

The diameter of the tube should be of sufficient size to allow enough air to enter through the tube to replace the liquid being discharged. When air begins to enter the tank through the tube, the apparatus will begin to function as a constant-head device.

Mr. Sarjeant's equation states that the pressure head at the bottom of the tube is $h_A = h_2 - h_3$ where h_3 is the amount of liquid drained at any instant. This equation is incorrect as the initial depth, h_0, has been neglected. See the accompanying Fig. 1.

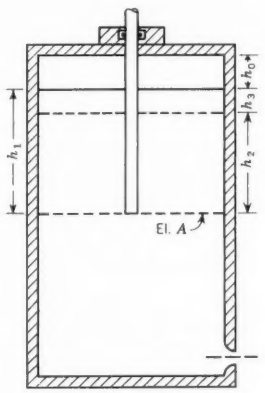


FIG. 1.

To calculate more accurately the value of h_3', the maximum drop of the water surface, before the apparatus will begin to function as a constant-head device, the following calculations are submitted.

Assuming constant temperature during the drawdown and no air entering the system:

$$p_0 h_0 = p_1 (h_0 + h_3)$$

where p_0 = initial pressure, in psia, of the air above the liquid
p_1 = pressure in psia of the air above the liquid after the liquid level has dropped an amount h_3

Thus $$p_1 = \frac{p_0 h_0}{h_0 + h_3}$$

or the pressure head $$\frac{p_1}{\gamma} = \frac{p_0 h_0}{\gamma(h_0 + h_3)}$$

The value of h_A now is,

$$h_A = h_2 - \frac{p_0 h_0}{\gamma(h_0 + h_3)}$$

In the limit just before air enters the tank, $h_A = 0$. Therefore

$$h_2' = \frac{p_0 h_0}{\gamma(h_0 + h_3')}$$

$$\text{or } h_3' = \frac{p_0 h_0}{\gamma h_2'} - h_0$$

but $h_2' = h_1 - h_3'$. Therefore

$$h_3' = \frac{p_0 h_0}{\gamma (h_1 - h_3')} - h_0$$

where h_3' is the required drop of the liquid surface before the apparatus will begin to function as a constant-head device.

The solution of the equation for h_3' may be readily solved by trial and error when p_0, h_0 and h_1 are given. It can also be found by solving the quadratic equation,

$$h_3' = \pm \sqrt{h_0 h_1 + \left(\frac{h_0 + \frac{p_0}{\gamma} - h_1}{2}\right)^2} - \left(h_0 + \frac{p_0}{\gamma} - h_1\right)$$

Note that $h_3' = 0$ when $h_0 = 0$.

Joseph C. Kent, M. ASCE
Asst. Prof. of Civil Eng.
Univ. of Washington
Seattle, Wash.

Idea of a "managed America" threatens individual freedom

To the Editor: I was both alarmed and dismayed to see the article, "Urban Renewal and Federal Legislation," by R. L. Dickman, M. ASCE, appear in the October issue, p. 43. It seems incongruous indeed that a professional magazine representing the oldest of the Founder Societies, and one dedicated to the fundamental precepts that made both our nation and our profession great, should print such an article.

I was alarmed to see the bland, detached manner in which men were referred to as mere factors in a formula, as if individual freedom, individual initiative, personal desires and dreams could be magically represented by some empirical coefficient. I was alarmed to see that the power and growth of the Federal Government's activity in urban renewal was pointed to with pride, as if this facet of collectivization represented some admirable accomplishment.

I was alarmed to see property owners who did not choose to surrender their private property, or to recognize what were determined by others to be their "needs," pictured as obstacles to social progress. I was alarmed to see, in the last paragraph, the naive implication that another step in the idea of the "managed America," advocated by our vertical intellectuals, will lead us to a healthy and stable economy. Such a total disregard for the lessons of history certainly is not consistent with the concept of a truly progressive, enlightened profession.

James M. Abernathy, A.M. ASCE
Civil Engineer
Brown & Root, Inc.
Houston, Tex.

Rising corners of two-way roof slabs

To the Editor: In "The Readers Write" section of the August 1960 issue, p. 93, Douglas S. Laidlaw gave a qualitative explanation for the observed fact that the corners of simply supported, two-way roof slabs rise somewhat in service. This phenomenon can be studied quantitatively by referring to the theory of laterally loaded homogeneous elastic plates (see Timoshenko's *Theory of Plates and Shells*, McGraw-Hill, 1940).

Edge twisting couples dictated by boundary conditions are statically equivalent to distributed edge shearing forces plus concentrated reactions at the corners. The magnitudes of the hold-down force could be computed theoretically and applied with some confidence to the design of a prestressed slab in which cracking is not permitted. A precise calculation of this nature would not be applicable to a slab with ordinary reinforcement but may be used as a guide.

Mr. Laidlaw has found a very practical method for coping with the problem through calking of the crack after it appears. My approach to the situation would be to compute the hold-down forces required for a homogeneous elastic slab and determine the size and number of corner dowels and vertical wall reinforcement required to perform this function. If the amount of reinforcement proves to be impractical or uneconomical, calking would then become the desirable alternative. I believe that experience, such as Mr. Laidlaw's, would be the best teacher on this problem.

William Weaver, Jr., M. ASCE
Asst. Prof. of Civil Eng.
Stanford University
Stanford, Calif.

Are savings from welding exaggerated?

To the Editor: A cost comparison indicating considerable savings by the use of welded beam connections is given in Mr. Saxe's article, "Why Not More Welded Structures?" in the August issue, p. 53. The figures do not include the cost of additional weight or fabrication, or both, required for the columns. The complications of fixing beam ends involve an almost infinite number of possibilities from both a design and a cost standpoint, and I do not believe any generalization is valid.

The statement that there is normally little change in the weight of columns due to fixing beam ends overlooks the fact that the "little" change is always in favor of bolted construction; that the "little" change may be substantial for exterior columns; and that additional fabrication and metal will normally be required for interior columns to transfer the beam moments through the columns. The matter is not simple.

Mr. Saxe's conclusion that fabricating shops know that welded construction reduces costs is not borne out in my practice. Having spent a lot of time supervising crews of welders, I now permit field welding only under rigid supervision. The cost of supervision is generally a deterrent to field welding. I permit shop welding but it is not often used.

Mr. Saxe implies that welded beam-and-girder roof construction for factories and schools will save considerable expense, but savings on the order of 25 percent are impossible using welded connections if the roof construction in general use today is followed, that is, a system of suspended and cantilevered beams. This system achieves nearly all the savings inherent in fully continuous members with a bare minimum of shop and field work.

I have just encountered a contract price of $230 per ton erected and painted for a factory roof in North Carolina with an area of 300,000 sq ft, with typical bays 40 ft by 60 ft. The price includes 100-ft simple truss spans over an area of about 17,000 sq ft.

The practicing engineer's liability is increased enormously by field fabrication, which is what welded connections boil down to. It is probable that a general awareness of this, rather than ignorance as the author implies, is responsible for reluctance to change to welded construction, even if, as remains to be proven by a separate analysis of every job, the cost of welded construction is actually less.

Wm. T. St. Clair, F. ASCE
Engineer

Richmond, Va.

Regarding welding symbols

To the Editor: May I call attention to the misuse of welding symbols in the article, "Why Not More Welded Structures?" by Van Rensselaer P. Saxe, F. ASCE, in the August issue, p. 53.

When the weld symbol is shown above the line, it indicates that the weld is on the far side of the joint with respect to the arrowhead. In Fig. 1, the symbol for the fillet weld on the end of the cover plate calls for the location of this weld at the end of the cover plate nearest the column. Also the symbol for the bevel groove weld of the beam flange to the column indicates that the beam flange is beveled on the bottom side.

Obviously it is not intended that either of these welds should be made as the symbols indicate.

M. C. Magnuson, F. ASCE
Chicago, Ill.

Author replies to both discussers

To the Editor: With reference to Mr. Magnuson's letter [above] about the welding symbols used in Fig. 1 of my article in the August issue, he is referring to a condition where the actual groove to be welded is not shown on the drawing as has been done in this illustration. In this case the groove to be welded is shown, and the welding symbol is correct for the indication given on the drawing.

With regard to the discussion of my article by Mr. St. Claire [above] I would like to take up his points paragraph by paragraph.

First and second paragraphs. Most engineers designing continuous-moment welded steel structures use semicontinuous connections for all wall columns and connections to spandrel beams, unless wind or earthquake resistance is required.

Third paragraph. My statement about fabricating shops is based on the design of nearly 2,000 welded structures, many of which were requested redesigns of riveted and bolted work. As an illustration see *Engineering News-Record*, March 9, 1950, on the Sun Papers Publishing Plant. Also see *Engineering News-Record's* recent account of the welded steel frame for the United Engineering Societies Building in New York, N. Y. Many more articles could be cited, such as one on the Veterans' Hospital, (*Welding Engineer*, Sept. 1952). Field and shop inspection should be done only by men employed by testing laboratories. These men should be qualified welders themselves, as they can guide and instruct field and shop welding operators rather than criticize them.

There is no advantage in permitting shop welding and then requiring field bolting. Such a procedure only makes complicated and more costly connections. Our work is designed so that the field welding is 80 to 90 percent of the welding required. Field welding is as good as shop welding.

Fourth paragraph. Based on experience covering many jobs, the quoted percentage savings in the article are correct. The use of Case C construction is worth investigation following recommendations of the AISC bulletin, "Welded Interior Beam-to-Column Connections." The primary purpose of economical welded design is to save steel tonnage, thereby saving steel costs. Welded design permits truly engineered connections, thus securing practically indestructible connections, which do not get loose and are highly resistant to acid air conditions, which produce rust between the parts that make up other types of connections.

Sixth paragraph. The practicing engineer's liability is no greater on a welded structure than on any other type of structure, be it reinforced concrete or structural steel, when a qualified inspection and testing laboratory does all the shop and field inspection. Since very few engineers have time to supervise the shop and field inspection of the construction of their work, it has always been the writer's feeling that every job should be inspected by disinterested, independent laboratories.

Van Rensselaer P. Saxe, F. ASCE
Consulting Engineer

Baltimore, Md.

A first edition of Trautwine's "Pocket-Book"?

To the Editor: In checking through some old technical books I have had for a number of years, I find what appears to be a first edition of *The Civil Engineer's Pocket-Book,* by John C. Trautwine, Civil Engineer. The book was published by Claxton, Remsen and Haffelfinger, Philadelphia, in 1872.

I do not know whether this is truly a first edition and, if so, whether it has any historical or commercial value as such. If any of your readers can help me out on the matter, I would be more than glad to receive their comments.

James W. Darling, F. ASCE
Consulting Engineer
1108 Orange Ave.
Fort Pierce, Fla.

Corrections to Sewer Design Manual defended

To the Editor: We have reviewed Prof. M. G. Spangler's letter, in your October 1960 issue (p. 108), expressing his objections to the corrections to the ASCE Manual 37 on sewer design which we published in the July 1960 issue (p. 79). We would like to answer these objections.

There was considerable discussion, while the Manual was being prepared, by a number of members of the Joint Committee, the members of the Task Force Committees and other interests, regarding the proper factors of safety to use when designing pipe. The question was finally resolved at a meeting of the Joint Committee and the Task Force Committees in New Orleans, where it was decided that the Manual should recommend a minimum factor of safety of 1.5 for the design of all rigid pipe. This would include both non-reinforced and reinforced concrete pipe. The recent publication of changes to the Manual with regard to the factor of safety was done in order to make the Manual agree with the majority opinion of the people who worked on the preparation of this document. All preliminary drafts and review copies of the Manual included the statement that a minimum factor of safety of 1.5 should be used in the design of all rigid pipe. The wording that is being changed apparently crept into the text during editorial revisions of the galley proofs.

We cannot agree that the application of a uniform safety factor for both non-reinforced and reinforced concrete pipe is an archaic concept; it is a concept that is based on the experience and judgment of the men who worked on the preparation of the Manual.

The last three paragraphs in Professor Spangler's letter seem to overlook the fact that the design of precast reinforced-concrete pipe sewers has to be predicated upon the specified minimum strength requirements of an acceptable specification such as ASTM C76. Obviously, no one waits until a batch of pipe is made and tested before choosing the design criteria. The ratio of minimum ultimate strength to minimum 0.01-in. crack strength of ASTM C76 pipe is 1.5 for all classes except Class V, where the ratio is 1.25. Therefore, the use of a factor of safety of 1.5 will always result in designs with working strengths not greater than the 0.01-in. crack strength. We certainly agree that the design working strength should never exceed the 0.01-in. crack strength for any pipe.

The Editing Committee, *ASCE Manual of Practice for the Design and Construction of Sanitary and Storm Sewers*

B. H. Swab, *Chairman*
H. H. Benjes
S. W. Jens
R. R. Kennedy
J. C. Lawler
H. S. Smith
A. L. Tholin

Soil mechanics volume honors Dr. Karl Terzaghi

At a session of the Soil Mechanics and Foundations Division, held during the Boston Convention, Dr. Karl Terzaghi, Hon. M. ASCE, received a special volume of his writings compiled by his colleagues in the Soil Mechanics and Foundations Engineering Department at Harvard University. Originally intended as a 75th birthday tribute to Dr. Terzaghi, the volume was finally published in time for his 77th birthday. It includes Dr. Terzaghi's most important writings, a complete biography, plus appropriate contributions on his life and achievements written by the editors.

The book, entitled "From Theory to Practice in Soil Mechanics," is dedicated to Dr. Terzaghi. He is cited as "courageous thinker, eminent scientist, world-famous civil engineer and engineering geologist, the founder and pioneer of modern soil mechanics." Dr. Arthur Casagrande, F. ASCE, Gordon McKay Professor of Soil Mechanics and Foundation Engineering at Harvard and a member of the editorial board in charge of publication, made the presentation at an overflow session of the Division. He said in part:

"Few men in a lifetime have exerted an influence on their profession to compare with that of Karl Terzaghi on civil engineering and engineering geology. Yet his writings and practice are so diverse, have covered so long a period, and have stemmed from so many countries that the full scope of his career remains unrealized by even his closest associates.

"With the approach of his seventy-fifth birthday we started preparation of this book. Its purpose is to present a detailed account of Terzaghi's personality, his professional achievements, and his method of working. To the greatest possible extent the essence of his contributions is presented in his own words. When set forth in orderly sequence and supplemented by explanatory comments, Terzaghi's writings and reports show clearly how he proceeded, step by step, first to establish the fundamental principles of soil mechanics and then to use them as powerful tools in his engineering practice. Hence the contents of this book provide an ideal means to demonstrate, especially to young engineers, the prerequisites and techniques for successfully practicing soil mechanics. This belief was not only one of the incentives for the preparation of the book but it was also responsible for the selection of the title." The book is available from John Wiley & Sons, Inc.

Other honors accorded Dr. Terzaghi during Convention week included the establishment of a new ASCE award in his name. He also received the Ewing Medal of the British Institution of Civil Engineers.

Merry Christmas Happy New Year

ASCE NEWS

Phoenix Next on Convention Calendar

Phoenix and the Arizona Section will be host to the next Convention of ASCE, set for the Westward Ho Hotel, April 10-15. One of the nation's favorite vacation spots, Phoenix ("in the valley of the sun") is an inspired choice for an end-of-the-winter convention. Plenty of inducements to engineers to attend the Phoenix Convention and bring their families along for a vacation will be apparent when the full program of technical and social events is printed in the February issue. In the meantime, a dozen committees—under General Convention Chairman Elmer Maggi—are working hard to make the Phoenix Convention the best ever.

The program theme will be water resources—a perennially vital subject in the dry Southwest—and all the Technical Divisions are organizing their programs to highlight water. Advance information from J. J. Turner, public relations program chairman, mentions some of the interesting papers already in the works.

The Power Division program will include a paper on "Conservation of Cooling Water." In Structural Division sessions there will be papers on "The Construction of Penstocks and Scroll Cases on the Lewiston Hydroelectric Project"; "Offshore Drilling Rigs"; and "Concrete Dams." Among Irrigation Division papers there will be two on different aspects of water conservation—"Irrigation System Design for Re-use of Irrigation Water" and "Use of Return Flow in Irrigation Project Design."

Various phases of the water problem will be discussed in Sanitary Engineering Division papers. Among slated subjects are "Pollution of Ground Water by Synthetic Detergents"; "Water Quality Due to Radioactive Fallout"; and "Status of Saline Water Conversion Program." On the Soil Mechanics and Foundations Division program, there will be papers on "Control of Seepage and Drainage"; "Slope Protection Along Reservoirs"; and "Foundation Problems of a Drainage Tunnel." This Division will also feature four special papers dealing with Arizona soils problems.

At least four papers of special interest to the Southwest are scheduled for Waterways and Harbors Division sessions—"Waves on Inland Reservoirs"; "Stabilization of the Channel of the Colorado River Below Parker Dam"; "Stabilization of the Channel of the Rio Grande in New Mexico"; and "The Pecos River Plan." Even the Pipeline Division will relate its papers to water—"Pipeline Crossing of the Colorado River"; "Feather River Pipeline Project" and "Phoenix Water Pipeline Project."

Phoenix—sightseeing center

Visitors to the Phoenix Convention will find much to do and enjoy in addition to the organized events on the social program. Swimming, golfing, and horseback riding are among the sports and recreations available from the headquarters hotel. From Phoenix, which is called the "sightseeing center of the Southwest," it is only a few minutes to Indian schools and pueblos; to museums and botanical gardens, where desert flora and fauna can be studied; to rodeos and Indian dances; to Taliesen West, unique home and school of celebrated architect, Frank Lloyd Wright.

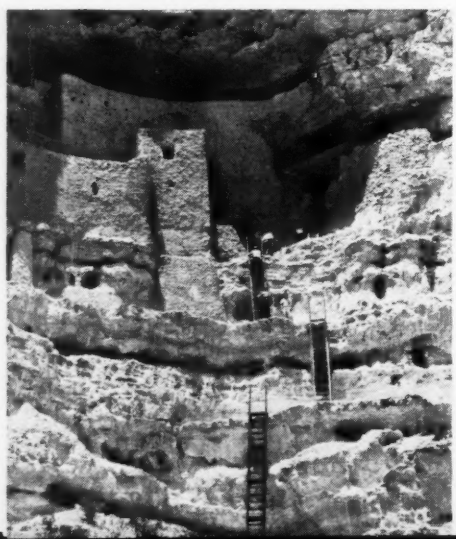
Further (but not too much further) afield there are old ghost towns, such as Jerome and McMillenville; famous gold mines; copper pits in production; forests of rare cacti; historic frontier communities; cliff dwellings and Indian mesa towns; colorful canyons, such as Oak Creek; petrified forests and painted deserts; and seventeen different National Parks and Monuments. Engineer visitors to the area may want to take side trips to one or all of the three great Upper Colorado River dam projects—Glen Canyon, Flaming Gorge, and Navajo dams.

Then there is the matter of weather. The U.S. Weather Bureau calls Phoenix "the driest, sunniest, clearest resort area in the United States." In April, Convention month, the temperature averages a comfortable 75 degrees.

Only two Conventions in 1961

Members planning to attend a Society Convention in 1961 are reminded that only two have been scheduled instead of the usual three. The Phoenix Convention will combine many special features of the usual Summer and Winter Conventions.

Sightseeing attractions of the Phoenix area include "Montezuma Castle," ancient and interesting cliff dwelling.



The Hotel Westward Ho, official Convention headquarters, offers the last word in luxurious living. Though centrally located in the heart of the downtown shopping area, it provides a restful resort atmosphere complete with patio and king-size pool.

ASCE Overseas Units

ASCE Overseas Units are organized to provide a means for professional association among resident or transient members outside the United States. Members traveling in an area served by an Overseas Unit are invited to contact the Secretary concerning activities.

ASCE Overseas Unit, Australia
J. A. Saftich, *Secretary*
P.O. Box 17
Milsow's Point, N.S.W.
Australia

Shown at first meeting of Australian Overseas Unit of ASCE (reading left to right) are: J. A. Saftich, M. ASCE, unit organizer and secretary; Joseph Dougherty, guest speaker, representing the American Consulate General in Sydney; Harold W. Holdaway, president of the unit; and Robert C. Miller, project engineer for Kaiser-Perini-Morrison-Raymond, and the technical speaker.

ASCE Overseas Unit Formed in Australia

ASCE members living in Australia have formed an Overseas Unit, the first to be organized under a policy recently adopted by the Board of Direction. It is expected that the Overseas Units will provide an opportunity for ASCE members living abroad to get together for technical and social programs in areas not served by ASCE Local Sections.

ASCE will act upon petitions for formation of a unit from members in foreign countries after clearing the proposed unit with the appropriate engineering society or societies in the country involved. There will doubtless be programs in which Overseas Units and local engineering organizations will want to cooperate.

The first meeting of the Australian Overseas Unit was held recently at the University of New South Wales in Sydney. As guest speaker, Joseph Dougherty, representative of the American Consulate-General in Sydney, hailed the formation of the ASCE group. In the featured technical talk, Robert C. Miller, M. ASCE, project engineer for Kaiser-Perini-Morrison-Raymond, described the construction of Tumut-2 Power Project on the Upper Tumut River. Brief talks were also given by Harold W. Holdaway, M. ASCE, president of the Overseas Unit, and J. A. Saftich, M. ASCE, organizer and secretary of the new unit.

Metropolitan Section Sponsors N.Y. World's Fair Program

More than half a billion dollars will be spent in connection with the New York World's Fair 1964-1965, Maj. Gen. W. E. Potter (ret.), executive vice president of the fair corporation, told the Metropolitan Section at its November meeting. Some $95 million is being spent for permanent highway improvements leading to Flushing Meadows, site also of the 1939-1940 World's Fair. The fair corporation itself will let $15 million in contracts in early 1961 for utilities, to be installed next summer. (It is estimated that 80 percent of the utilities from the earlier fair are reusable.) This will leave two years for building.

The World's Fair 1964-1965 Corporation will operate with a staff of 200, compared to 6,000 for the 1939-1940 fair. Almost everything will be contracted to private operators. Land will be leased for the two years at $8 per sq ft for U.S. industries and $6 per sq ft in an international area. There will be no lease charges for governmental units. Each exhibitor will design, build, and demolish his own structure. He may build on 60 percent of his area up to a height of 80 ft.

Some 40 million people are expected at the fair in 1964 and 30 million in 1965, at $2 each. The Brussels Fair in 1958 drew 42 million, of whom only one million came from outside of Europe. Themes of the fair are "Peace through Understanding" and "Man's Role in the Physical Universe."

General Potter commented that only three of twenty world fairs in the past 100 years have made money. He predicted that this one would make substantial profits; the fair corporation plans to offer soon 6 percent bonds to finance preparation of the site.

Past President Franklin Thomas Honored by Caltech

The five-story California Institute of Technology building, formerly known as "Engineering," is being renamed the Franklin Thomas Engineering Laboratory in memory of ASCE Past President Franklin Thomas, civil engineer and dean of students, who helped solve some of Southern California's major water problems.

Dean Thomas, who served Caltech for 39 years as professor of civil engineering, was also chairman of the Colorado River Board of California, a charter member and vice chairman of the Metropolitan Water District, and vice chairman of the Pasadena Board of City Directors.

According to Dr. Frederick C. Lindvall, chairman of Caltech's Division of Civil, Electrical, and Mechanical Engineering and Aeronautics, Dean Thomas "was well known nationally as an engineer and in the local community as a professional man with unusually broad community and cultural interests. It is particularly appropriate," he added, "that this engineering building be named in his honor for his many years of devoted service to the Institute as its first chairman of engineering."

Division Doings

Construction Division

The Construction Division is actively promoting comprehensive papers on research in construction as material for possible use in the Division Journal. The Publications Committee will contact government agencies and the larger contractors, asking them to encourage writing up data they have developed on interesting engineering projects and submitting them for consideration.

It is hoped that more research work will be undertaken and records kept with the idea of sharing knowledge gained with other engineers. Construction engineers who have data that can be made available are asked to submit them through the Manager of Technical Publications. A new Authors' Guide to Technical Publications is available for the asking.

Engineering Mechanics Division

Establishment of a Task Committee on Flow Around Objects in a Non-Uniform Velocity Field is announced by the Engineering Mechanics Division. This new task force, formed under the Fluid Dynamics Committee, will study the effects of wind velocity gradient on wind loads for tall buildings. Other practical situations to be considered are the forces on sediment particles on stream beds, forces and scour patterns around bridge piers, and forces on piles and other objects subjected to wave action. The effects of man-made structures and topography upon the diffusion of air pollutants will also be studied.

The members of the Committee are W. D. Baines, J. E. Cermak, P. S. Eagleson, W. L. Moore, and R. H. Sherlock, with Sydney Frank, D. J. Portman, and S. Eskinazi, as advisers. All are active in the field and hope to sponsor a technical session at a future Society Convention. Because of the meagre amount of information available on the subject, the committee would like to hear from any Society member concerned with either research in the field or applications of flows with velocity gradients. Information can be sent to any committee member.

The Division also urges members to start thinking about the West Coast Conference on Applied Mechanics, to be held at the University of Washington, Seattle, August 28-30, 1961. Prof. B. J. Hartz, of the University of Washington, heads the 1961 West Coast Conference Committee, and Prof. K. S. Pister, of the University of California, is secretary. The other members are Professors J. M. Gere and T. H. Lin and Dr. Lars Skjelbreia.

Conference papers should be submitted to the Manager of ASCE Technical Publications, with a note to the effect that they are intended for the West Coast Conference and a request that they be referred to the Engineering Mechanics Division. All papers chosen for presentation at the conference will be published in the Division Journal. ASME authors should send their papers directly to Prof. J. Miklowitz, California Institute of Technology, Pasadena, who is program chairman.

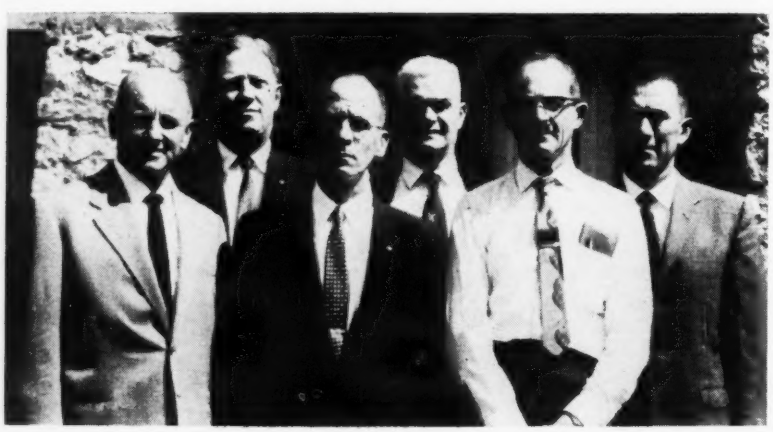
The 1960 West Coast Conference, held at Cal Tech last June, brought together over 150 specialists in the field from all over the country. The conference is an annual event, sponsored jointly by the ASCE Engineering Mechanics Division and the ASME Applied Mechanics Division.

Waterways Division

The Task Committee on Channel Stabilization Works of the Waterways, and Harbors Division held its organizational meeting at El Paso, Tex., this fall. The committee was recently formed under the direction of the Committee on Regulation and Stabilization of Rivers to collect and analyze data on current practices in channel stabilization of alluvial rivers in the United States. The results will be reported in Technical Division Journals and in Convention programs.

At the two-day organizational meeting arrangements were made to present three papers on bank stabilization at the Phoenix Convention next spring. The task committee also reviewed the broad phases of its projected work, and made specific work assignments. Harvill E. Weller, of Vicksburg, Miss., is task committee chairman.

Task Committee on Channel Stabilization Works meets in El Paso. Pictured in front row, in usual order, are Joseph F. Friedkin, chairman of the Waterways Division Committee on Regulation and Stabilization of Rivers (the sponsoring group); Francis F. Escoffier; and Albert Bettle. In back row, left to right, are Oliver A. Johnson, Task Committee Chairman Harvill E. Weller, and Daryl B. Simons.



ASCE Membership as of November 9, 1960

Fellows	11,214
Members	16,161
Associate Members	19,006
Affiliates	107
Honorary Members	47
Total	46,535
(Nov. 10, 1959	44,151)

ASCE-EJC Sponsor Tour of Swedish Engineer

Dr. Evert Arne Bjerhammar, of the Swedish Royal Institute of Technology, is on a two-month lecture tour of U.S. engineering colleges. The tour is sponsored by Engineers Joint Council and ASCE under a grant from the National Science Foundation, and is coordinated by the Surveying and Mapping Division of ASCE.

Dr. Bjerhammar, professor of geodesy at the Royal Institute in Stockholm, is well known in international surveying circles. He has specialized in optical and electronic distance-measuring devices, paralyx triangulation automatic mapping, and applications of the calculus of matrices to the method of least squares.

His tour includes some 25 colleges and universities throughout the country. In addition to addressing photogrammetry and geodesy graduate and undergraduate students, Dr. Bjerhammar will also hold conferences and seminars, and address Local Section and Student Chapter groups.

Prof. Arthur J. McNair (left), of the Cornell University Surveying Department, welcomes Dr. Evert Arne Bjerhammar, distinguished Swedish engineer and lecturer, to Cornell.

ASCE ENGINEERING SALARY INDEX

(Prepared Semiannually)

Consulting Firms

City	Current	Previous
Atlanta	1.21	1.38
Baltimore	1.14	1.14
Boston	1.23	1.22
Chicago	1.49	1.45
Denver	1.25	1.24
Houston	1.26	1.26
Kansas City	1.15	1.13
Los Angeles	1.32	1.28
Miami	1.38	1.57
New Orleans	1.22	1.18
New York	1.29	1.25
Pittsburgh	1.07	1.07
Portland (Ore.)	1.24	1.27
San Francisco	1.34	1.30
Seattle	1.06	1.06

Highway Departments

Region	Current	Previous
I, New England	1.03	1.01
II, Mid Atlantic	1.15	1.14
III, Mid West	1.29	1.27
IV, South	1.12	1.12
V, West	1.16	1.06
VI, Far West	1.17	1.17

Sole purpose of this Index is to show salary trends. It is not a recommended salary scale. Nor is it intended as a precise measure of salary changes. The Index is computed by dividing the current total of base entrance salaries for ASCE Grades I, II, and III, by an arbitrary base. The base used is $15,930, the total of salaries paid in 1956 for Federal Grades GS5, GS7 and GS9. Index figures are adjusted semiannually and published in CIVIL ENGINEERING. Latest survey was July 30, 1960.

SOCIETY AWARDS AND FELLOWSHIPS AVAILABLE

DANIEL W. MEAD PRIZES:	*1961 contest closes May 1, 1961. See 1960 Official Register, page 149. Topic for 1961 contest announced in July issue (page 43).*
FREEMAN FELLOWSHIP:	*1961 contest closes March 1, 1961. See Official Register, page 154.*
J. WALDO SMITH HYDRAULIC FELLOWSHIP:	*1961-62 contest closes April 1, 1961. See Official Register, page 156.*
RESEARCH FELLOWSHIP:	*1961 contest closes Jan. 1, 1961. See Official Register, page 156.*
ERNEST E. HOWARD AWARD:	*Closing date Feb. 1, 1961. See Official Register, page 148.*

Canadian Engineers Host To ECPD Annual Meeting

The Engineering Institute of Canada was host to the Engineers' Council for Professional Development for its 28th annual meeting held in Montreal early in October. There were 220 registrants at the meeting, from the United States, Canada and Mexico. The two-day program featured talks by Dean W. L. Everitt, of the University of Illinois, and president of ECPD; Col. L. F. Grant, past-president of ECPD and of the Engineering Institute of Canada; and Alan Jarvis, editor of *Canadian Art* and a well-known Canadian TV and radio speaker. ASCE was represented by Executive Secretary William H. Wisely.

Forum talks and discussions covered the work of the Committees on Education and Accreditation, Student Development, Recognition, and Development of Young Engineers.

A highlight of the meeting was the introduction by the Committee on the Development of Young Engineers of its new booklet, "Citizenship and Participation in Public Affairs." The attractive 24-page booklet is designed to encourage young engineers to take an active part in community and other public affairs. It is introduced by a "Manifesto" by former President Herbert Hoover, Hon. M. ASCE, urging engineers to assume their rights and duties as citizens. Practical suggestions are given for individual participation in community activities and in politics. The effectiveness of group action taken by Detroit engineers in matters of public interest and concern comprises one section of the manual. The ECPD creed, "Faith of the Engineer," is also included.

The booklet is available from ECPD, 29 West 39th Street, New York 18, N. Y., for 25 cents per copy. Discounts are available for quantity orders. Industrial leaders are ordering the book for distribution to their younger engineers.

Stephen Bechtel Receives John Fritz Medal

Stephen D. Bechtel (left), F. ASCE, engineer-contractor of San Francisco, received the John Fritz Medal at the Society's annual dinner during the Boston Convention. ASCE Past President E. R. Needles made the presentation. The medal, which is sponsored by the five Founder Societies, is awarded annually for notable scientific or industrial achievement in engineering.

The Younger Viewpoint

This month's editor

With this month's edited copy for "The Younger Viewpoint" the Committee received the following note from Albert Nelson, representative for Zone II.

"It is with a sense of regret that I must, with this article, submit my resignation from the editorship of Zone II, and the Committee on Younger Member Publications.

"I have served in this position for about two years, and feel that it would be in the best interests of the committee to acquire an editor from some other locale, with some fresh thinking. This, coupled with the fact that I have recently entered private practice and find my time at a precious premium, makes it necessary for me to resign.

"This experience for me has been rich and rewarding, and I find my interest in ASCE and Younger Members has grown. I have enjoyed my association with you, Mr. Alpern, and the other members of the Committee."

The resignation of Al Nelson is accepted with reluctance. He has been a faithful, interested, and hard-working member of the Committee. Congratulations to Al on his decision to enter private practice as a land surveyor in South Miami, Fla. The Committee wishes him the best of luck and good fortune.

Engineers in the Armed Services

To date, The Younger Viewpoint has not been exactly overwhelmed by letters from young engineers in the Armed Services. Therefore, we welcome this month's letter penned by a former Air Force Officer and edited by Al Nelson to fit the space available. The letter is printed here not to be controversial, nor as a criticism of our Air Force, but as one man's opinion of conditions as he found them. The author suggests that these problems probably apply to other branches of the Services as well. If we are to move forward in the sixties as President-Elect Kennedy has asserted in his campaign, certainly one of the big problems is retaining young engineers of high caliber in the Services. If a candid appraisal of engineers' working conditions in the Services is represented by the following letter, it might be well to call it to President-Elect Kennedy's attention because a great deal of America's progress and defense status will increasingly rest on the shoulders of American engineers and scientists.

"To The Younger Viewpoint:

"There is considerable concern in the higher echelons of the Air Force about the low rate of 'retainability' of young officers with engineering backgrounds and training. Of such great concern is this subject that at a spring meeting of the District of Columbia Society of Professional Engineers John M. Ferry, Special Assistant for Installations to the Secretary of the Air Force, spoke on the problem.

"Having recently been one of the young officers that the Air Force did not retain, I feel somewhat qualified to go into some of the reasons why people such as myself do not elect to remain in uniform. I did not stay in the Air Force, and I have some well defined ideas and reasons for this decision. I can also vouch for the fact that these reasons and ideas are in general the things that go through the heads of other officers. The question is not whether these thoughts are valid. The real question is how can the Air Force meet these challenges, replace erroneous concepts with the true when they exist, or correct improper situations when they exist?

"I will discuss a half-dozen factors which affect a person's attitude toward his job, and show how the Air Force job situation is thought of in these areas by the young officers under discussion.

"(1) *Importance of Individual Work.* I have found that at base level proper recognition is often not given to what are known as 'support' personnel. The problem here is not the importance of the Service engineer's work, but the attitude of his superiors toward his contribution. I feel that a more enlightened attitude by local commanders could almost eliminate this problem.

"(2) *Authority and Responsibility.* Vice Admiral H. G. Rickover has said of the engineer, 'He must be completely independent of lay direction in the *performance* of the operation. However, he will be most certainly judged by the *results* of the operation.' I have found that in too many cases the Air Force has lay persons directing the performance of the engineer. To overcome this difficulty perhaps the engineer could be treated in a manner similar to the pilot. Pilots are judged primarily on results, and are not unduly hamstrung by performance restrictions. Under such a system an engineer would, I think, feel considerably more free to go about his work.

"(3) *Knowledge Required for the Work.* As an engineer, I feel equal regard should be given to the knowledge of the engineer, which in almost all cases was attained without government expense. Furthermore, I noted that a large number of engineers were not fortunate enough to be assigned, as I was, to engineering positions. I cannot help but feel that the Air Force errs in not making a greater effort to utilize the engineer's skill, talent, and training properly.

"(4) *Recognition.* The Air Force has a tendency to regard its engineering personnel as something equivalent to a glorified grounds keeper. Recognition of the fact that the engineer is the possessor of important, useful information would do away with this problem.

"(5) *Dignity Inherent in the Position of Officer.* On occasion engineers are required to accomplish tasks somewhat below the general level of dignity expected of an Air Force officer. This is mainly a local problem.

"(6) *Financial.* Although I found no fault with the Air Force policy of higher pay for flying personnel than for support personnel, it does seem inequitable to reward with higher pay and accelerated promotions other non-flying professional people.

"(7) *Conclusion.* In conclusion, I definitely feel that if more of the high-caliber work were entrusted to the Air Force engineering officer, and an atmosphere of direction by trained people and judgment by results existed, the financial question would not cause so many of them to leave the service. All that most engineers want is an opportunity to make real contributions to challenging, interesting work in a dignified manner with reasonable financial return.

"NICK W. STIEGLITZ, A.M. ASCE"

We encourage opinions and/or answers to the viewpoints presented in this column. Letters should be sent to either the Zone representatives or the chairman of the committee. The opinions expressed in the letters presented in The Younger Viewpoint do not necessarily reflect the opinion of the committee or of ASCE. The aim of the department is to reflect opinions of the membership, encourage discussion, and in so doing encourage the ASCE Board of Direction and officers to take action or establish policies that will best serve the membership and promote professionalism of the engineer.

Committee on Younger Member Publications

Walter D. Linzing, Chairman; 4751 No. Paulina, Chicago 40, Ill.

Zone I	Zone II	Zone III	Zone IV
Donald Kowtko 289 Foxhill Road Denville, N. J.	Albert C. Nelson 250 N.E. 51st Street Miami, Fla.	William R. Walker 4600 Franklin Ave. Western Springs, Ill.	Judd Hull 6000 S. Boyle Ave. Vernon, Calif.

ASCE CONVENTIONS

PHOENIX CONVENTION
Phoenix, Ariz.
Hotel Westward Ho
April 10-14, 1961

ANNUAL CONVENTION
New York, N. Y.
Hotel Statler
October 16-20, 1961

HOUSTON CONVENTION
Houston, Tex.
Hotel Shamrock
February 19-23, 1962

TECHNICAL DIVISION MEETINGS

AIR TRANSPORT CONFERENCE
Miami, Fla.
May 11 and 12, 1961
Sponsored by
Air Transport Division
Airport Operators Council

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DISTRICT CONFERENCES

NEW ENGLAND COUNCIL
Boston, Mass.
Massachusetts Institute of Technology
March 25, 1961

PACIFIC SOUTHWEST COUNCIL
Phoenix, Ariz.
Hotel Westward Ho
April 10-14, 1961

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the fifth of the month preceding date of publication)

Outstanding engineers and educators presented technical papers at the **Alabama Section's** two day fall meeting held in Mobile in October. The opening feature was a symposium on engineering education (see photo), in which C. G. Ames discussed engineering training as background for industrial operations, Harvey Pierce spoke on the engineer's role in continuing education, and Dean Fred H. Pumphrey of Auburn University, talked on engineering education at the cross roads. Later in the day a boat trip from Mobile to Dauphin Island enabled engineers and their wives to inspect first-hand the Mobile Harbor and Ship Channel. The following morning the members heard about space engineering from James J. Danaher, Jr., head of the Army Engineers Special Projects Branch in Mobile, who presented a paper on "Facility Design for the Nike ZEUS Program"; Fred Robeson, Corps of Engineers, who discussed "Foundation Design Problems in Connection with Army Missile Projects"; and Capt. D. A. Scherer of the U.S. Navy at Pascagoula, who described "The Modern Submarine and Problems of its Construction." All told over 200 attended the meeting.

The financial structure of the **Akron Section**—dues and obligations—was explained at the November meeting by Luke Sveda, chairman of the Auditing Committee. To assure operating the Section suitably, members present voted unanimously to raise local dues to $3.00 per year for Associate Members and $5.00 per year for Members and Fellows. Featured technical speaker was Walter Podolny, chief engineer of George S. Rackle & Sons, Inc., of Cleveland, who gave a helpful talk on prestressed concrete.

The **Savannah Branch** of the **Georgia Section** recently heard E. M. Kennedy, senior resident engineer for the Georgia Highway Department, speak on the Lazaretto Creek Bridge. He reported the successful use of a retarding agency in the concrete to reduce shrinkage cracks. Concrete strength was improved by using the admixture with one cylinder testing at 9,000 psi in compression test. During the business meeting Benjamin Gay was elected vice president to fill the unexpired term of William R. Smith who is relocating in Charleston, S. C.

The **Illinois Section** has established a five-man committee of structural engineers to study and report on a recent ruling by Chicago's City Building Commissioner George L. Ramsey, that "full application of concrete slabs, pre-tensioned or post-tensioned is not in the public interest." The Section's Board of Directors will study the committee report before taking further action.

Ralph Gray, chairman of the board of the Armco Steel Corporation, spoke to the **Kansas City Section** at its October meeting on the threefold problem

(Continued on page 84)

Over 200 members and guests met in Mobile, Ala., in October, for the fall meeting of the Alabama Section. Left-hand photo shows Emanuel A. Drago (left), general chairman of the meeting, discussing the program with Section President R. Orrick Davis and Harry E. Myers, first vice-president.

A symposium on engineering education was one of the featured events of the meeting. Pictured in right-hand photo are guest speakers C. G. Ames (left), chief engineer for Scott Paper Company, Mobile; Harvey Pierce (center), of Miami, Fla.; and Dean Fred H. Pumphrey, of Auburn University.

Less weight, less wind resistance and better drainage for three new bridges with USS AmBridge I-Beam-Lok Flooring

Rugged, lightweight USS AmBridge I-Beam-Lok flooring substantially cut dead weight in these new bridges, while also giving them low wind resistance and better drainage because of its high percentage of open floor area. With no scaffolds to erect or forms to build, I-Beam-Lok went in faster. And it will last longer—with very little maintenance. ☐ There are two types of USS AmBridge bridge flooring: 5″ open I-Beam-Lok, and 4¼″ and 3″ concrete-filled I-Beam-Lok. The filled type is available in units 6′ wide and up to 49′ long that apply directly to stringers on spans from 6′ up to 8′ centers. The open type is also available for spans up to 4′ centers. For more details, contact one of our offices or write for our 32-page catalog.

USS, AmBridge and I-Beam-Lok are registered trademarks

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American Bridge Division of United States Steel

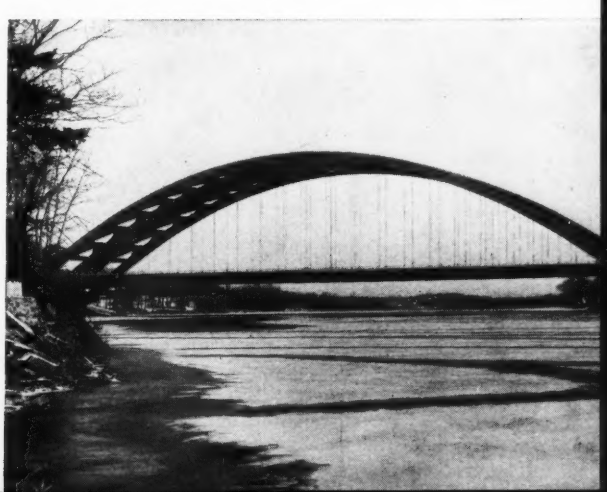
Watch United States Steel's special Christmas show, **The Coming of Christ**, in Color on NBC-TV, Wednesday, December 21, 8:30 P.M., E.S.T.

This mark tells you a product is made of modern, dependable Steel.

Houghton-Hancock Bridge, Michigan. This double-deck vertical lift bridge is one of the heaviest lift bridges ever built, with three operating positions. Highway traffic is carried on the upper deck and railroad traffic on the lower deck when the bridge is in the lowest position. When the bridge is raised to the intermediate position, highway traffic uses the lower deck of the lift span. The first or lowest position, 7′ above water, is normal during the winter months. The second or intermediate position, 35′ above water, permits small craft to pass underneath without interrupting vehicular traffic, which passes over the lower deck. The third or highest position, 100′ above high water, will accommodate large ships. To save weight, 12,645 square feet of 5″ open grid I-Beam-Lok was used on the lower deck, 15,278 square feet of 4¼″ concrete-filled I-Beam-Lok was used on the upper deck and 9,040 square feet of 2″ concrete-filled Tee-Type sidewalk flooring was used for the sidewalks of both decks. It totaled only 277 tons—or but 12% of the weight of the giant lift span. Designed by Hazelet & Erdal, Consulting Engineers.

Saginaw River Bridge, Michigan. This bascule bridge carries U. S. Route 23 over the river just north of Saginaw. It is 593′ long, with two 29′ roadways, two 2′6″ sidewalks and a 4′ median strip. There are five spans, including a double-leaf bascule span 170′ long, which provides a 150′ clear channel. 9,756 square feet of 5″ TR-type open I-Beam-Lok, weighing 92 tons, was used for the roadway floor. The lightweight I-Beam-Lok, with its approximately 80% open floor area, not only cuts down the dead weight, but also minimizes wind resistance when the spans are raised. The open area also provides automatic draining and snow removal. Designed by Hazelet & Erdal, Consulting Engineers.

Mohawk River Bridge, New York. This graceful new bridge features separate 600′ through girder arch spans side by side, with three beam spans at each end of the arch. The center rise is 120′ high. A dual highway with 42′ roadways and sidewalks accommodates auto and foot traffic. 9,500 square feet of 5″ open I-Beam-Lok was used for gutter strips on each side of the spans for drainage and snow removal. The I-Beam-Lok units were erected speedily—top-side—without scaffolds or forms, and ready for use immediately. The gutters will have a long, trouble-free life, because I-Beam-Lok won't crack or buckle. Snow and frost won't affect it, either. Designed by Frankland & Lienhard, Engineers.



facing the steel industry today—competition from other products, making a profit while on a low-percent of capacity, and the inroads made by foreign competition. Of the three, the last poses the most serious threat. High wages and inefficiency of operation by both management and labor, according to Mr. Gray, are a price handicap in meeting foreign competition.

Road building in Alaska was featured at the October meeting of the **Jackson Branch** of the **Mid-South Section.** Frank Redus, soils engineer for Michael Baker, Jr., Inc., of Rochester, Pa., was principal speaker. One problem, peculiar to the Arctic regions, encountered by the firm in connection with the design of a 30-mile stretch of highway, was the presence of permafrost. In instances where it is impossible to avoid building the highway over it, great care must be taken not to disturb the forces of nature which keep the ground permanently frozen. Mr. Redus concluded his talk with some facts of general interest on the forty-ninth state.

A highly successful meeting opened the **Philadelphia Section's** new season. Sponsored by the Section's Construction Division, the meeting was held jointly with the Philadelphia Chapter of the American Public Works Association and included special guests from the Philadelphia Post of the Society of American Military Engineers. Speaker of the evening was Brig. Gen. Thomas H. Lipscomb, North Atlantic Division Engineer, Corps of Engineers, whose subject was missile base construction. Although special emphasis was given to the Air Force's $1 billion Atlas program, General Lipscomb reviewed the history of completion-time specifications in weaponry, present-day requirements of speed in weapons manufacture and installation structures and machinery, and the problems encountered by the Corps because construction and research and development must be carried on simultaneously. He emphasized that, despite much publicity to the contrary, the missile base construction program of the Corps of Engineers, for the Air Force, is proceeding on schedule and within budgetary appropriations.

The joint fall meeting of the **Texas and Oklahoma Sections** was a marked success with over 440 members, wives, and guests participating. The meeting theme, "Civil Engineering in the 60's," was introduced by ASCE President Frank A. Marston, who noted many aspects in which civil engineering and our Society are changing. During the business session outgoing Section President I. W. Santry handed the gavel over to the new president of the Texas Section, James R. Sims, who in turn introduced the new vice president, Joe J. Rady and the executive secretary, Edmund P. Segner, Jr. The technical sessions, a popular part of the program, were so well attended that at times the meeting rooms overflowed. An indication of the interest stirred up by the more than 20 participating speakers were the discussions overheard in the lobby and elsewhere following the sessions.

At recent Toledo Section meeting Tom Anderson (center), of the Anderson Grain Elevators, Maumee, Ohio, explained more than 500 uses for corn cobs to members in attendance. Shown with him are Robert W. Kirk (right), and Robert W. Juergens, secretary-treasurer.

Indiana Section Board of Directors poses at recent Section dinner meeting. In the front row are, left to right, Vice President August Compton, President Joseph Hnot, Jr., and Secretary Thomas A. Duwelius. In the back row, left to right, are Arthur P. Arndt, Joseph I. Perrey, James R. Cooper, Wallace W. Webb, and Treasurer Malcolm D. Hale.

LOCAL SECTION MEETINGS

Cleveland—Thirty-fifth annual banquet at the Cleveland Engineering and Scientific Center, the evening of January 20.

Los Angeles—Annual dinner meeting in the Regal Room at the Carolina Pines Banquet Hall, on December 14, at 6:30 p.m. Cocktails will be served in the Jamaica Room beginning at 6:00 p.m.

Metropolitan—Regular monthly meetings in the Engineering Societies Building on the third Wednesday of each month, at 7:00 p.m.

Mid-South—Annual Spring meeting in Vicksburg, Miss., April 27-29. Host for the occasion is the Vicksburg Branch.

Philadelphia—Regular monthly meeting at the Engineers' Club on January 10, at 7:30 p.m.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday, at 12 noon.

South Carolina—Annual winter meeting with the South Carolina Society of Engineers at the Wade Hampton Hotel, Columbia, S.C., January 27.

BY-LINE WASHINGTON . . . .

You can figure on relatively quick action in at least four areas that will affect your business, as a result of the recent elections. None of them will be radical as campaign talk would make it appear, but all could help boost the business barometer for the construction industry.

The four: school construction aid; "new starts" for Bureau of Reclamation and Army Engineers; urban renewal and housing; more money for stream-pollution-abatement works. All four of these failed of passage last session, but there was really little difference between the political parties on principles involved, only on language and definitions. So there is little doubt of passage this time—though campaign promises could be pared down considerably.

There are other things that will certainly be proposed, as soon as the new Administration is officially in power, but chances for passage are slimmer. One of these is a proposal for a cabinet-level "Department of Urban Affairs" to consider big-city problems and consolidate numerous functions now carried on by the Corps of Engineers, the Public Health Service, and others. Congressmen from areas outside the big metropolitan centers haven't looked favorably on the idea of a new department. Although minimum wage is strongly opposed in detail it will get another try. "Common situs" picketing permission still isn't given too good a chance, despite the efforts of labor.

You can look for a whole string of proposals from the new President, after January 20. Some of them may look like real hair-raisers to businessmen. President-elect Kennedy has made some definite commitments in various areas, and has a strong program of his own—and he will act, as he must, with the full assumption of the power and the following to carry them out.

It should be kept in mind that Congress is the real top dog now, and will remain so for at least a year. And Congress is basically conservative—even more so since the small gains made by the Republicans in both Senate and House. It is dominated by the Southern Democrats, who have opposed radical measures almost without a break over the past two years. Their Republican counterparts can join them—just as in the past two years—to block anything they don't like. In fact, without the necessity of "going along" with their own President, the Republicans are even freer than before to oppose.

The problem for Mr. Kennedy (as it would have been for Mr. Nixon, of course) is that he can demonstrate no great popular following, and thus threaten to go over Congress' head to get his way—as President Eisenhower could and did. So—although the Presidency does give him considerable power, such as patronage, that can be used for leverage on recalcitrant Congressmen—he will have to play the game much more closely with Congress than President Eisenhower ever did.

There are side-aspects that should also be considered in looking at the picture for the next year: There will certainly be two budgets submitted to Congress—the first by President Eisenhower, the second by Mr. Kennedy, as soon as possible after he takes office. In previous changeovers of this sort, the outgoing President's budget has generally prevailed, with some changes, simply because the new Administration has neither the time nor the opportunity to make them.

* * *

The National Bureau of Standards has established two new advisory committees, to aid in cooperation with industry and engineers in the fields of precision measurement, calibration, and standard practices. The committees are the Advisory Committee on Calibration and Measurement Services and the Advisory Committee on Engineering and Related Standards. William Wildhack, special assistant to the NBS director, will be chairman of both groups.

* * *

U.S. Government backing—in the form of financial insurance—is the prime requirement before U.S. engineering and contracting firms can compete equitably with foreign firms for business abroad. That's the gist of what a 16-man committee told the U.S. Department of Commerce last month. What's needed, said the construction men, is (1) a government-backed credit program that would enable them to extend long-term credit on a competitive basis with foreign contractors, and (2) insurance against arbitrary cancellation of contracts in foreign countries.

* * *

Continuing urban and industrial growth, and rising property values, indicate that by 1980, the nation's potential flood losses could climb to nearly $1 billion a year in flood areas, the Senate's Select Committee on National Water Resources now estimates. The estimate is based on a report by the Corps of Engineers. The answer, said the committee, is to complete work now under way or authorized for the Corps (about $5 billion worth), and build another $6.5 billion worth of new projects.

* * *

The U.S. Public Health Service has high hopes for the success, this month, of its National Conference on Water Pollution (in Washington, Dec. 12-14). More than 1,000 persons have signified they will attend, and some 70 speakers have been lined up. Its purpose is to develop public support for national pollution-abatement programs and suggestions for carrying them out. (There's a big construction stake in this, of course—it's been estimated that it will take $4.6 billion just to catch up with municipal treatment needs by 1968, another $2 billion to catch up with industrial requirements.)

* * *

The first major construction figure to leave government employ after the election was Ellis L. Armstrong, since 1958 Commissioner of Public Roads. He will become president of the newly-formed Better Highway Information Foundation in Washington, devoted to aiding the federal-aid highway program through informational work. Frank C. Turner, Deputy Commissioner and Chief Engineer, will be acting head of the BPR (under Highway Administrator Bertram D. Tallamy) until a new appointment is made.

WILL PERFORM FOR A CENTURY WITH A RIVER ON ITS BACK

At left, you see a length of cast iron pipe being installed under the Floyd River in Iowa. This is part of a water feeder main which will reinforce the existing water supply system.

Despite the severe conditions of a river overhead, the inherent ruggedness of cast iron pipe promises at least a century of trouble-free performance, and rarely requires repairs or replacement.

And cast iron pipe's cement lining assures a continued full flow of water year after year. It's no wonder that more than 90% of the pipe used for water supply systems in our 50 largest cities is cast iron pipe!

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News Briefs . . .

Moles Awards for New York and Texas Men

Harry T. Immerman, F. ASCE, of Larchmont, N. Y., and Herman Brown of Houston, Tex., have been named as the 1961 recipients of The Moles awards, given annually for "outstanding achievement in construction." The announcement was made at a dinner meeting of The Moles, New York association of leading figures in the tunneling, dam-building, and heavy construction industry, held at the Biltmore Hotel on November 2. Formal presentation of the honors will be made at the organization's annual awards dinner on January 25.

H. T. Immerman

Herman Brown

The winners constitute the 21st pair honored in a series that started in 1941 and numbers among its winners former President Herbert Hoover, Robert Moses, Adm. Ben Moreell, Peter Kiewit, Harvey Slocum, and Lou Perini. The award, considered the top recognition for service to the American construction industry, is made annually to one Moles member and one non-member.

Mr. Immerman, the member winner, is vice president and chief engineer of Spencer, White & Prentis, Inc., New York City, with which he has been connected since 1923. A native of New York, he has been called upon several times by the city for expert testimony on foundation, underpinning, and shoring problems, and has served as consultant on these matters to industrial organizations.

Mr. Brown, a native of Belton, Tex., is president of Brown & Root, Inc., a Houston enterprise that has grown out of a company he founded in 1914. The company has been responsible for a total of more than $2,150,000,000 worth of construction projects all over the world.

Unique Built-up Roof for Providence Post Office

Three and one-half acres of unique roofing protect the nation's first fully automatic post office, opened late in October in Providence, R. I. The roof for the $20,000,000 post office consists of thin-shell parabolic barrel arches, which average about 8 in. in thickness and are supported by twelve structural steel columns. Slopes for the unusual roof vary from zero to 60 deg. From the concrete shell outward the roof was constructed in successive stages, using Johns-Manville built-up roofing. This consisted of concrete primer, rag felt, insulating material, more rag felt, cement, and finally white mineralized split sheet Slatekote, which gives the roof its beautiful white finish. The structure was designed by Charles A. Maguire and Associates, Engineers, and erected by the Gilbane Construction Company.

Pakistan to Reclaim Salt-Spoiled Areas

A $9,000,000 project for improving a blighted soil condition that is threatening West Pakistan's food supply has been launched by the West Pakistan Water and Power Development Authority. The project consists of drilling, developing, and equipping 1,000 deep wells to reclaim land ruined by the encroachment of salt and to arrest further land losses. Salt encroachment has already affected half the country's arable farm land and is ruining an additional 100,000 acres annually.

The salinity problem is caused by the exceptionally high underground water level found in most of the Punjab area, which permits moisture to work its way through the soil to the surface. As the water evaporates, it leaves behind deposits of mineral salts. The high water table is also causing serious waterlogging of much of the land.

The wells will be used to lower the water table by stopping the upward movement of water through the soil. Each well will be equipped with a vertical pump to withdraw water from below the surface and pump it into irrigation canals. The canals will divert the surplus water to areas where the water table is normal and irrigation needed.

It is expected that the program will reclaim 1.4 million acres of land, with fringe benefits to an additional million acres. Eventually it will raise annual food production by 800,000 tons.

The consulting engineers on the project are Tipton and Kalmbach, Inc., of Denver, Colo., and the contractor is Harold T. Smith International, S.A. The Worthington Corp. has a contract for supplying and installing 1,000 vertical turbine pumps.

New Seaport will Expand Miami Shipping Facilities

Ground-clearing work has been started at the Dodge Islands site for Metropolitan Miami's new $20,000,000 seaport. Designated the Port of the Americas, the long-debated project is expected to strengthen the city's position as maritime gateway to Latin America. Plans call for developing a usable port by 1962, though the complete project may take five years.

About a half mile from downtown Miami, the port will be linked to the mainland by a vehicle-rail causeway. It will consist of three major units, increasing the present port area from 36 to 187 acres.

Construction Spending Declines in October

The value of total new construction put in place in October amounted to $5.1 billion, according to preliminary estimates of the Bureau of the Census of the U.S. Department of Commerce. This amount represented a normal seasonal drop of 3 percent from September and was about the same as in October 1959.

Total new construction expenditures in the first ten months of this year amounted to $45.9 billion, 2 percent less than the total for the first ten months of 1959. According to the Bureau of the Census, in making comparisons with data for 1959 it should be noted that (beginning with September 1959) estimates reflect the effects of steel shortages resulting from the steel strike.

In the first ten months of 1960, the cumulative value of total private expenditures was $32.5 billion, compared to $33.1 billion in the same period of 1959. In this period the cumulative value of private nonfarm residential expenditures was $18.4 billion, 10 percent less than the amount spent in the comparable period of 1959. Public construction expenditures in the first ten months of this year amounted to $13.5 billion, 3 percent below the total for the first ten months of 1959.

Institute Formed for Steel Scaffolding and Shoring

The Steel Scaffolding and Shoring Institute, a national non-profit organization with headquarters in Cleveland, has been formed by a group of leading manufacturers in the field. According to ASCE Director John B. Scalzi, associate professor of engineering at Case Institute of Technology, and newly appointed managing director of the Steel Scaffolding and Shoring Institute, the objective of the organization is to promote recommended criteria and inspection procedures for steel scaffolding and shoring. The program will be in the interest of public welfare and safety as well as of the steel scaffolding and shoring industry. Recommended code data for the use of steel scaffolding and shoring to support formwork in connection with concrete construction will be made available to regulatory agencies concerned with codes and ordinances pertaining to this important phase of construction safety.

Regular membership in the Institute is open to organizations which manufacture steel scaffolding or steel shoring in the continental United States. Associate membership is available to independent distributors of these products, steel and other suppliers to the industry, and others interested in the objectives of the Institute. Applications should be addressed to Dr. John B. Scalzi at 2222 Mt. Vernon Blvd., East Cleveland 21, Ohio.

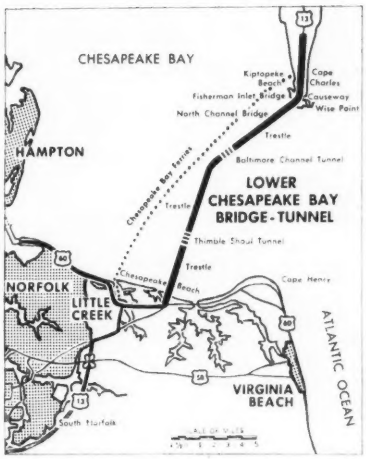
Long Concrete Trestle for Chesapeake Bay Crossing

More than two-thirds of the projected 17.6-mile-long bridge-tunnel crossing of lower Chesapeake Bay will consist of a concrete trestle. Construction started October 26 on the long-debated crossing, which will connect Cape Charles and the Eastern Shore of Virginia with the Hampton Roads-Norfolk area, eliminating the last water barrier on the popular north-south "Ocean Hiway."

The 12-mile concrete trestle will be built by a team of three contractors—the Tidewater Construction Corp., Norfolk; Raymond International, Inc., New York; and Peter Kiewit Sons' Co., Omaha. Although the trestle design is similar to that used in the Pensacola Bay and Lake Pontchartrain crossings, the exposed position of the projected crossing, depth of water, and heavy marine traffic pose challenging construction problems. To reduce cost and speed construction, virtually the entire trestle will be assembled of concrete sections mass-produced at a plant now under construction near the Cape Charles ferry terminal.

Three-pile bents, spaced at 75-ft centers, will carry prestressed girders to form a 28-ft-wide roadway. The pretressed piles are 54 in. in diameter and will be driven open-end to depths of 70 to 170 ft into the bay. Three major groups of trestle components wil be mass-produced in the casting plant—cylinder piles, pile caps and deck slabs.

Because of the difficulty of operating floating equipment under the adverse weather conditions that often prevail in the exposed bay, the contractors plan to drive piles from a self-elevating mobile platform similar in design to the "Texas Tower" drilling platforms. A large crane mounted on this platform will sink cylinder piles to firm bearing by a combination of driving with a hammer and jetting with high-pressure water jets.

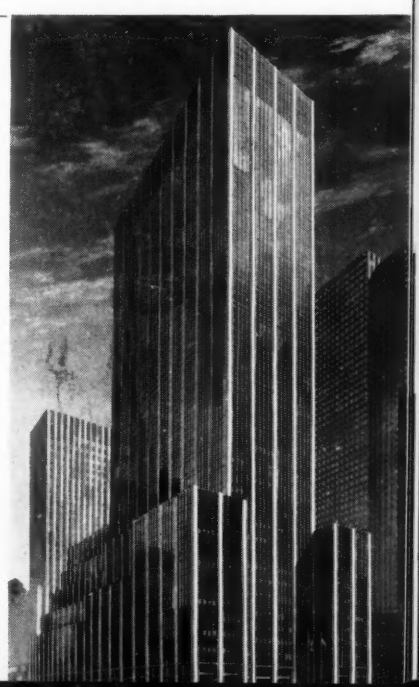


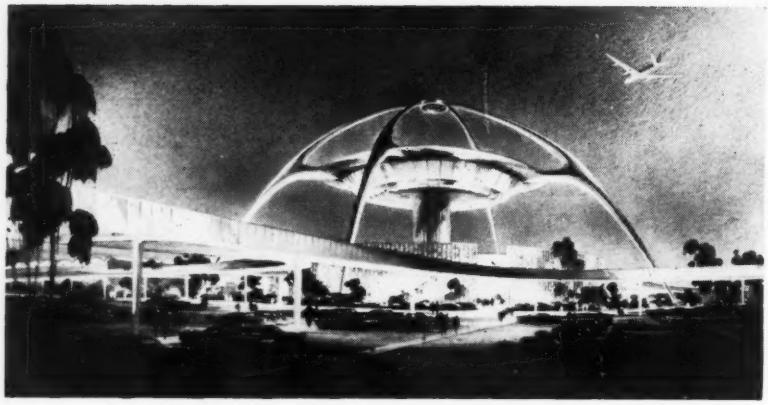
Because of its size and weight, the 75-ft-long concrete girder and deck slab will not be cast as a single unit, as was done on previous projects of this type. Instead, it will be manufactured in four separate units, each consisting of two 75-ft-long prestressed girders with separate deck sections. These units will be loaded onto barges and hauled to the site.

Scheduled for completion in the fall of 1963, the $139,200,000 bridge-tunnel project will replace an 80-year-old ferry service that has long been a traffic bottleneck. The long structure will require 55,000 tons of steel and 550,000 cu yd of concrete. The consulting engineers are Sverdrup & Parcel of St. Louis, and the traffic engineers Wilbur Smith and Associates, of New Haven, Conn.

Newcomer to Rockefeller Center Skyline

New 43-story office building, to be erected on the entire easterly blockfront of the Avenue of Americas between 51st and 52nd Streets, is shown here in architect's rendering. The 552-ft shaft-type building—a joint project of Rockefeller Center, Inc., and Uris Buildings Corporation—has been designed to harmonize with neighboring Rockfeller Center buildings. When it is finished early in 1962, it will provide some 1,700,000 sq ft of rentable space. Emery Roth & Sons are the architects, with Harrison and Abramovitz serving as consultants.





Plastic Sheathes Los Angeles Airport Theme Structure

Highlight of the $50,000,000 Los Angeles International Airport, due for usable completion in 1961, is the Theme Structure. The fanciful steel and concrete structure overlooking the 3,000-acre field consists of two great parabolic arches, with ground diameter of 340 ft. Hanging from the arches, 70 ft in the air, is a 100-ft-dia saucer of glass, steel, and concrete that houses dining facilities and an observation area. The whole Theme Structure is sheathed by a sprayed-in-place vinyl coating that beautifies the project and protects it from the elements. Architects are a joint-venture group consisting of Charles Luckman, Welton Becket and Paul R. Williams. The vinyl coating is based on a product of the Union Carbide Plastics Company and produced by Better Finishes and Coatings, Inc., Newark, N. J.

New Structural Steel Beams Available

The Bethlehem Steel Company can now include in regular rolling schedules eleven new lighter-weight wide-flange steel beam sections for the construction industry. They will be rolled at Bethlehem, Pa., and Lackawanna, N. Y.

The new sections are from 14 to 27 percent lighter than the minimum weights of wide-flange beams previously available in equivalent depths. They are expected to have special application to composite construction, and to structures designed using new plastic design techniques. The theoretical dimensions and properties for designing are shown in the accompanying table.

New Light Wide-flange Shapes

Theoretical dimensions and properties for designing

Nominal Size	Weight per Foot	Area of Section	Depth of Section	Flange		Web Thickness	Axis X-X			Axis Y-Y		
				Width	Thickness		I	S	r	I′	S′	r′
	lb	in.²	in.	in.	in.	in.	in.⁴	in.³	in.	in.⁴	in.³	in.
36x12	135	39.70	35.55	11.945	.794	.598	7796.1	438.6	14.01	207.1	34.7	2.28
33x11-½	118	34.71	32.86	11.484	.738	.554	5886.9	358.3	13.02	170.3	29.7	2.22
30x10-½	99	29.11	29.64	10.458	.670	.522	3988.6	269.1	11.70	116.9	22.4	2.00
27x10	84	24.71	26.69	9.963	.636	.463	2824.8	211.7	10.69	95.7	19.2	1.97
24x9	68	20.00	23.71	8.961	.582	.416	1814.5	153.1	9.53	63.8	14.2	1.79
21x8-¼	55	16.18	20.80	8.215	.522	.375	1140.7	109.7	8.40	44.0	10.7	1.65
18x7-½	45	13.24	17.86	7.477	.499	.335	704.5	78.9	7.30	31.9	8.5	1.55
New light beams												
B16L 16″ BL 16x5-½	31	9.12	15.84	5.525	.442	.275	372.5	47.0	6.39	11.57	4.19	1.13
	26	7.65	15.65	5.500	.345	.250	298.1	38.1	6.24	8.71	3.17	1.07
B14L 14″ BL 14x5	26	7.65	13.89	5.025	.418	.255	242.6	34.9	5.63	8.26	3.29	1.04
	22	6.47	13.72	5.000	.335	.230	197.4	28.8	5.52	6.40	2.56	0.99

New Water Plant for Suburban Washington

Cornerstone-laying for the Potomac River Water Filtration Plant at Rockville, Md., took place late in October. The cornerstone, containing a document box, was placed by Robert J. McLeod, M. ASCE, chief engineer of the Washington Suburban Sanitary Commission. With a capacity of 30 mgd, the new plant will supply Montgomery County and surrounding communities with treated Potomac River water.

The Malan Construction Corp., of New York City, is building the plant under two separate contracts amounting to over $5,500,000. Whitman, Requardt & Associates, of Baltimore, are the consulting engineers, and Fischer, Nes, Campbell & Associates, also of Baltimore, the consulting architects.

Waterways Experiment Station Plans Rebuilding

The Army Corps of Engineers has announced tentative rebuilding plans for getting its Waterways Experiment Station at Vicksburg back in full production. Early in October a disastrous fire destroyed the administration building and damaged other structures at the Station, one of the world's most famous technical centers. Property damage, estimated at over $1,500,000, includes the loss of a half-million-dollar IBM electronic computer, on lease to the Station, and other technical equipment. According to Col. Edmund H. Lang, F. ASCE, director of the 500-acre military installation, "the most serious loss of all is the volume of technical information, reports, and equipment which can never be replaced." Literally tons of reports and other irreplaceable material housed in the huge hydraulics library were lost.

Valuable lessons are to be learned from the fire. Most important, perhaps, is the need for fire-resistant construction and for fireproof files and safes. The brick building, constructed in 1954, had no sprinkler system. The fire also points up the desirability of having duplicate copies of vital documents and reports. Fortunately, many important documents were saved in the Waterways Experiment Station fire because they were in fireproof vaults.

Two new buildings will be constructed to replace the former administration building. One will house the executive offices, advisory and administrative staff, conference rooms, and cafeteria. The other will accommodate the entire Technical Services Division. A second-story wing, on columns, will be added to the Soils Division Building to house the Geology Branch and provide for the expansion of soils activities. An addition providing 2,500 sq ft of office space will be added to the Army Mobility Research Center.

In its 31-year history the Waterways Experiment Station has grown from a small hydraulics laboratory, devoted exclusively to hydraulic experimentation and flood control studies for the Lower Mississippi Valley, into the principal research and experiment facility of the entire Corps of Engineers in the fields of hydraulics, soils mechanics, flexible pavements, and concrete. The largest hydraulic laboratory in the world, the installation includes a 200-acre Mississippi Basin Model at the Station's sub-office near Jackson, Miss. Thousands of engineers and students from all over the world visit the Waterways Experiment Station annually and observe the operation of the large hydraulic models.

Texas Surveyors Meet with Surveying-Mapping Congress

The Texas Surveyors Association's Ninth Annual Short Course, held jointly with the Southwestern Regional Conference of the American Congress on Surveying and Mapping, brought together some 280 surveyors-engineers from Texas and eleven other states for discussion of surveying, local and regional. The program stressed accurate control in surveys for state, local, and regional mapping, location of highways, placement of shorelines, and spotting of oil wells and reserves.

Acknowledgment was made of the role of the ASCE Surveying and Mapping Division in pointing the way to the great future for surveying-mapping and in detailing the means to realize it. Alfred O. Quinn, co-author of the ASCE's original Surveying and Mapping Task Committee Report (Proceedings, Vol. 85, No. SU 1, Paper No. 2166, September 1959), noted that considerable progress has been made toward realizing the high potential of surveyor-engineers. He pointed out, however, that full realization cannot be achieved until the educational recommendations of the report are implemented by making available university-level engineering instruction in all areas of surveying and mapping.

Brother B. Austin Barry of Manhattan College, vice president of the ACSM and chairman of the Task Committee that produced the report, acknowledged that much remains to be done in the educational field to achieve results in each of the 50 states. Reporting the same view were educators from a number of other schools: W. W. Hagerty, dean of engineering at the University of Texas; P. G. Hoffman, chancellor of the University of Houston; S. R. Wright, head of civil engineering at Texas A. & M.; and R. M. Berry, professor of geodesy and surveying at the University of Michigan. All expressed the hope that their engineering curricula would soon attract and prepare students in surveying engineering. It was forecast that great strides in this direction will be made in the present decade.

Steel Output in First Ten Months of 1960

Steel production in the United States totaled 6,865,000 net tons of ingots and steel for castings during October, and 87,266,440 tons during the first ten months of this year, according to a preliminary report of the American Iron and Steel Institute.

The ten-month total is the sixth highest for any similar period on record, despite the decline in output during recent months. It compares with 74,189,206 tons made in ten months last year, when production was held down by the nationwide steel strike.

Through the first ten months of this year the industry operated at an average of only 70.3 percent of its 1960 capacity, yet produced nearly as much steel as was made in 1951 when the operating rate was over 100 percent of the then existing capacity.

Growth Plan Developed for Anchorage, Alaska

The engineering and planning firm of Wilsey, Ham & Blair, with headquarters in Millbrae, Calif., has been awarded a contract for preparation of a twenty-year development plan for the City of Anchorage, Alaska. The contract, to be finished next spring, is to provide a general plan for orderly growth of the city and its environs through 1980, and specific plans for a civic center, central business district, and all public utilities. The present population of the Anchorage area is 43,760, up some 288 percent from the 11,254 recorded for 1950.

The contract is financed in part by a grant from the Housing and Home Finance Agency.

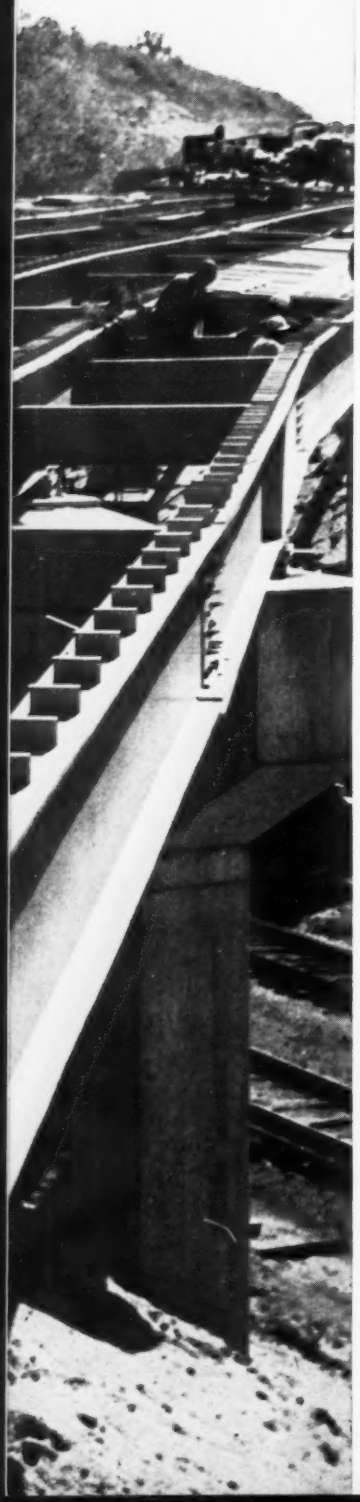
Forecasts 3 to 4 Percent Rise in Building Costs

Construction costs in the United States (exclusive of Alaska and Hawaii) rose 1 percent between April and October of this year, according to Myron L. Matthews, manager-editor of the Dow Building Cost Calculator. Coupled with a similar increase reported for the six-month period prior to April, this means a 2 percent increase in construction costs during the past twelve months. The increase is based on an averaging of building materials prices and hourly wage data sampled in 144 metropolitan areas throughout the country.

According to Mr. Matthews, "it takes $2.61 to buy and assemble the materials that $1.00 bought in 1941. This means that the 1941 building dollar is worth only 38 cents today." For 1961, he forecasts an annual increase of from 3 to 4 percent in construction cost.

Third Stage Reached in Cumberland Dam Construction

The last two concrete piers and three tainter gates will be built inside the center cellular cofferdam of the $13.5 million new Cumberland Dam in the Ohio River at Stratton, Ohio. Five of the eleven 110-ft-long control gates are of the submerged type seen at the right. The five can be lowered to permit water to pass over them or raised to permit flow below. Locks in the background have a 22-ft lift. The Dravo Corporation, of Pittsburgh, is the contractor on the Corps of Engineers job scheduled for completion next summer.



Now! Greater economy for ste
with new **A36** stru

Mechanical Properties

	A7	A373	A36
Yield Point, min. psi	33,000	32,000	36,000
Tensile Strength, psi:			
For shapes of all thicknesses	60,000 to 75,000	58,000 to 75,000	60,000 to 80,000
For plates and bars. Up to 1½ in., incl., in thickness	60,000 to 72,000		
For plates and bars over 1½ in., in thickness	60,000 to 75,000		
Elongation in 8 in., min., per cent	21	21	20
Elongation in 2 in., min., per cent	24	24	23

Chemical Requirements

	SHAPES		BARS		PLATES			
A7 C max.	...		...		...			
Mn	...		...		...			
Si	...		...		...			
			¾ in. & under	Over ¾ in. to 4 in.	¾ in. & under	Over ¾ in. to 1½ in.	Over 1½ in. to 4 in.	
A36 C max.	.28		.28	.28	.28	.28	.28	
Mn	...		...	.60/.90	...	.80/1.10	.85/1.20	
Si	...		...	...	...	...	.15/.30	
	Other than Group A	Group A heavy W.F.	1 in. & under	Over 1 in. to 4 in.	½ in. & under	Over ½ in. to 1 in.	Over 1 in. to 2 in.	Over 2 in. to 4 in.
A373 C max.	.28	.28	.28	.28	.26	.25	.26	.27
Mn	...	.50/.90	...	.50/.90	...	.50/.90	.50/.90	.50/.90
Si	...	...	...	...	...	...	.15/.30	.15/.30

BETHLEHEM STEEL

steel bridges and buildings

structural steel!

Steel

for strength
. . . economy
. . . versatility

- ***Adopted by the ASTM on June 16, 1960***
- ***Approved by the Bureau of Public Roads***
- ***Recognized by the A.I.S.C.***

ASTM Specification A36 covers carbon steel shapes, plates, and bars of structural quality not over 4 in. in thickness for use in the construction of bridges and buildings, and for general structural purposes.

10 PER CENT STRONGER THAN A7 AND A373

A36 has an increased yield point of 36,000 psi, and is approximately 10 per cent stronger than A7 and A373. The higher yield point of A36 allows increased design stresses using the same factors of safety.

WELDABILITY IS NO PROBLEM

A373 has been generally specified for welded construction of bridges and buildings. The chemical requirements at left indicate how closely A36 agrees with A373 in chemistry and, therefore, in weldability. Where weldability is required, the controlled chemistry will permit the use of A36.

INCREASE IN YIELD POINT SAVES WEIGHT

The substantial increase in yield point for A36 makes it a real bargain in strength-to-weight ratio at a very nominal cost. The weight saved by designing with A36 steel will result in even greater economy for steel construction.

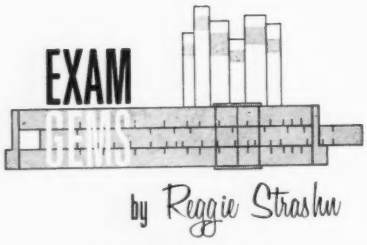
A36 IS AVAILABLE IN ALL SIZES AND SHAPES

A36 can be furnished from the same schedules and in all sizes and shapes in which A7 and A373 are rolled.

FOR MORE INFORMATION on new A36 steel, write for Folder 773, and Booklet 569. Or get in touch with the Bethlehem sales office nearest you.

BETHLEHEM STEEL

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.
Export Sales: Bethlehem Steel Export Corporation



R. ROBINSON ROWE, F. ASCE

EXAMGEM No. 17 gave the cable load on a pin-connected head-tower bent (Fig. 1) and asked for components of reactions and stress in each member. Novelty of the frame provoked some stress in the applicants; let's look at some of their reactions.

Algernon computed the angles at A correctly, but finding none right, he quit.

Bertram rotated the figure until T acted vertically like a load should, but this staggered the rest of the frame, and Bertie.

Cecil rotated LM to the vertical and resolved T into H=240 and V=576 acting at the end of a cantilever truss. Not bad.

Denis "assumed" half the cable H at each reaction and computed a division of the cable V for vertical components at L and M. Not good.

Eustace drew a force triangle for A and scaled AB=1200 and AC=1400. A nice start. Then he tried to draw one for B!

Ferdy recalled that the stem member of a T-joint is unstressed. Noting T-joints C, D and K, he rubbed out members BC, DE and IK. That made T-joints at B and I, so he erased BF and GI. Like a chain reaction, new T-joints F and G cleared EF and GH, then E cleared EJ, J cleared HJ, and H cleared HM. Only AL and AM were left. This was fun, but he found the hardest way to solve for stresses in these legs.

Geoffrey also cleared out the web members, but worried about collapse of the pin-articulated legs and put half of them back. That was all for little Geoff.

Humphrey marked zero on each web member without explanation and sketched 5-12-13 and 9-40-41 right triangles to support the rest of his computations, starting with moments about L:

$36M_v = 18 \cdot 240 + 80 \cdot 576$

$M_v = 1{,}400$

$L_v = 240 - 1{,}400 = -1{,}160$

$M_h = 1{,}400 \times 9/40 = 315$

$L_h = 576 - 315 = 261$

$AM = 1{,}400 \times 41/40 = 1{,}435$

$AL = 1{,}160 \times 41/40 = 1{,}189$

Actually half the applicants agreed with Hump's answers, but few did it as directly. The commonest labor-consuming step was computation of the perpendicular distance from L to the cable (80.77 ft) and multiply this by 624 for the right side of the moment equation. Also few took advantage of the integral triangles; others plunged unthinkingly into trigonometrical complexities.

Gem quality of the problem was 3-carat: the orientation of the frame, the progressive elimination of web members, and the integral-triangle set-up. All three rewarded the man who took time to think.

The next gem had a flaw of ambiguity accidental to its derivation from a foreign source. In the process of clarification, the data have been rounded freely, hoping to conceal the unfortunate background.

EXAMGEM No. 18

An irrigation system consists of a 12-in RC pipeline running level for 10,000 ft from a well and pump at one end to serve a series of lateral ditches with 0.05 cfs each at 100-ft intervals along the line. Using Manning's n=0.01486, compute the power lost to friction and the power which could be saved by a midline location of the pump.

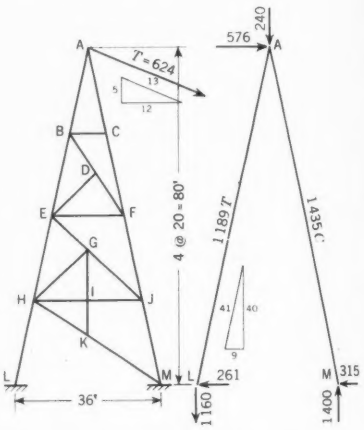
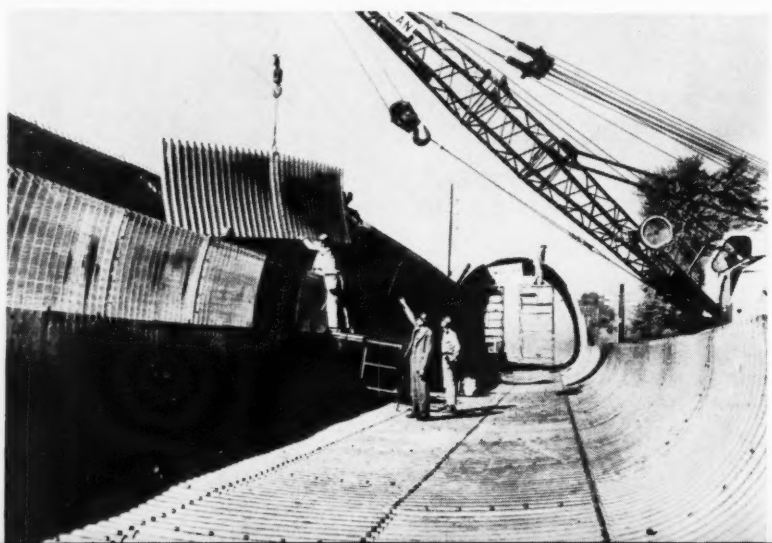


Fig. 1. With web dissolved and load resolved, the 2-leg bent was mostly solved.

Prefabricated Pipe-Arch Tunnels Speed Highway Project

Swinging a corrugated steel plate section into place, workmen for the American Bridge Division of U.S. Steel erect the side of a pipe-arch vehicular tunnel destined to carry traffic under Interstate Highway 74 between Peoria and Morton, Ill. The twin 334-ft-long tunnels, thought to be the largest pipe-arch structures ever fabricated, are being built side by side to carry two concrete traffic lanes. They require far less time to construct than conventional bridge-type underpasses.



Master Plan Authorized For Ventura County

A three-year study that will provide a master plan for development of California's Ventura County during the next 25 years has been awarded to Wilsey, Ham & Blair, engineers and planners, of Millbrae and Los Angeles. The contract was authorized by the Ventura County Board of Supervisors for the County Planning Commission.

Need for the study and plan stems from mounting population pressures from the mushrooming area comprising Los Angeles County, which adjoins Ventura County on the east and southeast.

In joint charge of the project for the engineers and planners are Abraam Krushkhov, director of planning, and Karl H. Baruth, principal planner. They are working closely with John D. Tapking, Ventura County planning director. The job will be done in three major one-year phases, to be completed in September 1963.

Contract Let for Sea Water Conversion Plant

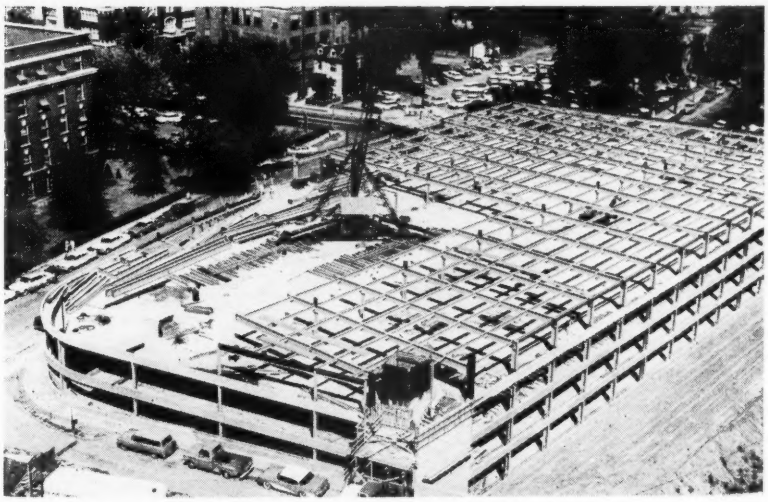
A construction contract for a sea water conversion plant has been awarded by the U.S. Department of the Interior's Office of Saline Water to the Westinghouse Electric Corporation. The project, the largest multi-stage flash-evaporator plant in the United States, will be located at Point Loma near San Diego, Calif., and its daily output of 1,000,000 gal of fresh water will be purchased by the City of San Diego.

The flash-evaporation process to be used consists essentially of spraying heated sea water under pressure into a chamber that is at a lower pressure and temperature. A portion of the water "flashes" into vapor and is then condensed, providing water that is nearly free of impurities. The remaining salty water passes through a series of additional chambers where the flashing process is repeated. At each additional stage the condensed, salt-free water is piped off.

The Fluor Corporation, of Los Angeles, is the architect-engineer, and the Ralph M. Parsons Company, also of Los Angeles, will participate in the engineering and work.

The plant is one of five authorized by the Office of Saline Water for testing the feasibility of processing sea or brackish water for agricultural, industrial, and domestic use.

Small Derrick Takes Over from Big Brother



A small stiff-leg derrick has just completed adding the steel for a fourth floor of the structure described in "Stiff-leg Derrick Solves Mud Problem on St. Louis Parking Structure" in the September 1960 issue of "Civil Engineering" (page 56). A big derrick set the steel for the first three floors in a single pass down the center of the 156-ft-wide building. Then little brother, with a 70-ft boom, 25-ft sills, and a capacity of 5 tons, took over to add now a deck that had been planned for the distant future. The small derrick made a U-pass to set the steel for the Ben Hur Construction Co.

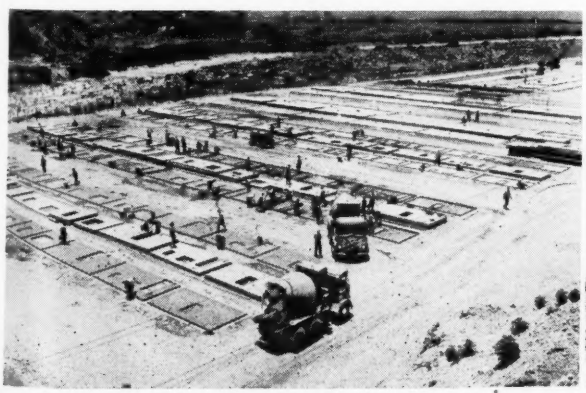
Precast Concrete Homes for Jamaica, B.W.I.

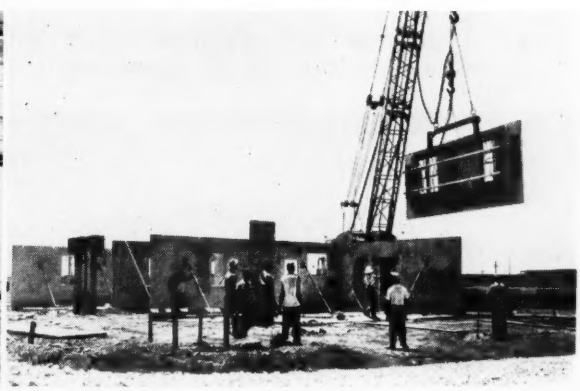
A new residential city for 10,000 people is being constructed overlooking Kingston Harbor on the southern coast of Jamaica. Called Harbor View, the project is unique in size as well as in the method of home construction being employed. Built on precast concrete walls, partitions, and roof sections, the homes are going up at the rate of six a day.

A 20-acre site for casting beds is located near the job. To keep these beds supplied, the main works yard has a stone and gravel plant equipped with a crusher as well as a ready-mix plant and a bituminous plant.

When the prefabricated sections are ready to be shipped to the job site, workers attach a vacuum cup grab unit to the precast member. The member is then lifted by crane onto a low-boy trailer and transported to the building site. Here it is lifted from the trailer and put into place by another crane equipped with the same type of vacuum system.

Construction of Harbor View started early this year and is expected to be completed late in 1961. When complete, the project will provide homes for some 10,000 people. Sites are also being prepared for shopping centers, schools, churches, playgrounds, and parks. The project is being developed by the West Indies Home Contractors, Limited, who report that the houses with lots will sell for about $6,000.



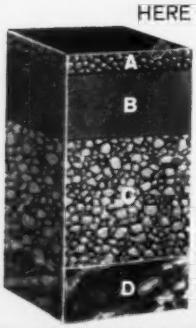


Part of 20-acre site for casting beds is shown in left-hand photo. At the construction site, seen in view at right, prefabricated sections are swung into place by a crane equipped with a vacuum cup grab unit.

North Carolina Highway Engineers

STAGE CONSTRUCTION IN WIDTH—This new section of N. Carolina's Interstate 85 is a good example of *stage construction in width*. Two new lanes (left), built with DEEP STRENGTH Asphalt pavement, have been constructed alongside existing two lanes of Route 70 (right) to form a new section of this Interstate Highway. This combination of DEEP STRENGTH Asphalt pavement and *stage construction* is helping states to stretch construction dollars and still provide necessary highways quickly.

HERE IS **DEEP STRENGTH**
DESIGN ON I 85

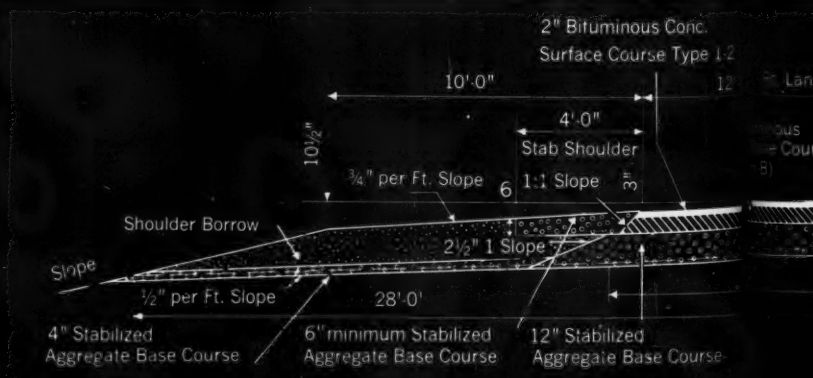


A
2-inch Asphalt concrete surface course

B
6-inch Asphalt concrete base course

C
12-inch Stabilized Aggregate Base Course

D
Subgrade



OLVE TROUBLESOME
OIL AND DRAINAGE PROBLEM

Build North Carolina Interstate 85
with new DEEP STRENGTH Asphalt pavement

new Guilford County section of Interstate No. 85, North lina Highway Engineers have chosen DEEP STRENGTH lt pavement.

Guilford County, engineers faced a difficult problem. The e soil in this area contains extensive strata of silty clay with moisture content which could weaken the support of a finished To eliminate this threat to Interstate 85, the foundation was fully proof-rolled with a 50-ton pneumatic tire roller to locate areas. These areas were then strengthened by replacing silty with suitable materials or installing necessary sub-drainage. s only after this painstaking effort that actual construction of avement structure was begun.

building this new part of Interstate 85, N. Carolina engi- followed several precepts of DEEP STRENGTH Asphalt ment design. Notice in pictures and cross-section (below) se of **6 inches of Asphalt base under 2 inches of Asphalt rete surface course . . . Asphalt surface treated outside lder . . . depressed median for good drainage . . . heavy proof- g of the subgrade . . . and use of high-contact pressure matic tire proof-roller on the aggregate base course.** is strength and durability!

hen designed like this—for DEEP STRENGTH—Asphalt pave- s *will carry the heaviest traffic loads without distress and with mum maintenance.* Also, use of Asphalt pavement avoids high ir costs due to damaging action of de-icing salts experienced ther pavement type.

BEST USE OF ROAD FUNDS

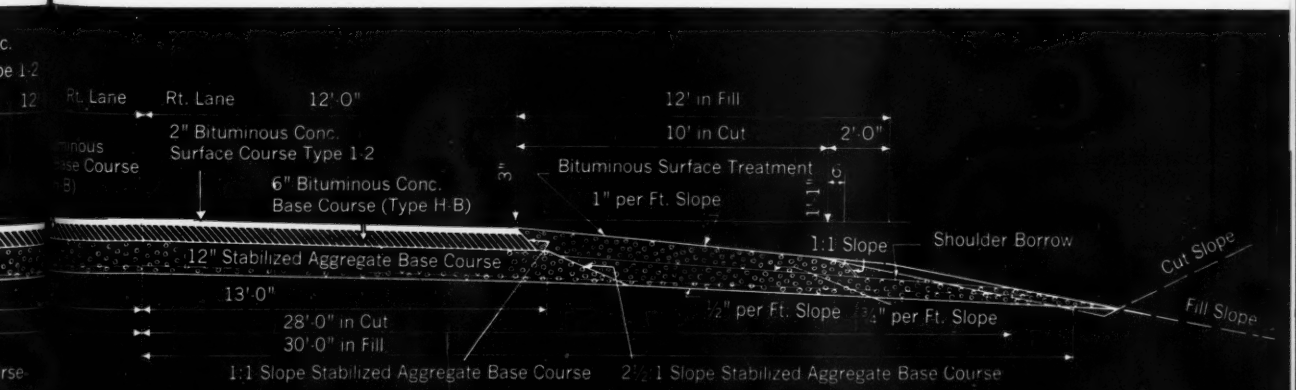
after state is finding that when Interstate Highways are built Advanced Design DEEP STRENGTH Asphalt pavements, the mum use is made of road building funds. That's because the nced Design Criteria permit inexpensive Asphalt base to be ituted, within limits, for more expensive Asphalt concrete cing. In addition, when Asphalt treated base is used in place of ated base, reduction in total structure thickness may be allowed.

E ASPHALT INSTITUTE

halt Institute Building, College Park, Maryland

Heavy compaction—This 50-ton rubber tire roller was used to proof-roll the subgrade. The aggregate base was proof-rolled with a 25-ton pneumatic tire roller exerting 82 psi contact pressure.

Outside Shoulders of stabilized aggregate base were Asphalt surface treated for width of 10 ft. One-half inch granite stone chips provide better traffic lane demarcation.



New in education

How to measure a scientific paper ....

During the next year a research project at the **Case Institute of Technology** will investigate the problem, "How do you measure the importance of a scientific paper?", with a grant of $16,800 from the National Science Foundation. Two approaches will be taken to identify the distinguishing characteristics of a variety of scientific articles published since 1900. The first, retrospection, will seek a way of determining the value of an article from its history after publication—the rate of increase or decline of citations of it over time. The second approach, prospection, will seek criteria for predicting the value of an article before it is published. Case hopes to make "some contributions toward making the entire process of communication among scientists more efficient."

MIT prepares for the future .....

Spurring major changes in the undergraduate program in civil engineering at the **Massachusetts Institute of Technology** is the recent Ford Foundation grant for $9,275,000. Modern physics, thermodynamics, fluid dynamics, electrical engineering, particulate mechanics (the study of particles such as those in soils), and materials engineering are among the subjects offered, for civil engineering of the future will extend into such areas as the construction of nuclear power plants and the design of automatic controls for transportation. According to Dr. John B. Wilbur, F. ASCE, head of the department, "Our objective is that of being the instigators of significant progress in the complex problem of engineering man's environment."

D. B. Steinman honored posthumously ..

City College of New York has named its new School of Technology building in honor of the late David B. Steinman, F. ASCE, bridge designer and alumnus of the college, as unanimously recommended by the Technology School faculty. The $9-million-six-story structure, to be completed in two years, will be erected on the college's uptown campus.

Water quality and pollution control ...

Water quality and pollution control are the subjects of two January courses offered by the **Robert A. Taft Sanitary Engineering Center,** environmental research laboratory of the Public Health Service in Cincinnati, Ohio. Sanitary engineers, scientists, and others concerned with aerobic treatment of organic waste waters from industries and municipalities should attend "Bio-oxidation of Industrial Wastes," January 9-20. Of interest to bacteriologists and persons engaged in bacterial water analysis in state, municipal, and other laboratories will be "Recent Developments in Water Bacteriology." Applications for information should be addressed to the Chief, Training Program, Robert A. Taft Engineering Center, 4676 Columbia Parkway, Cincinnati 26, Ohio.

A call to coeds .....

Young women who want to study engineering, science and architecture at **Rensselaer Polytechnic Institute,** beginning in September 1961, will find conditions more propitious than in the past. Under a program of affiliation between Rensselaer and its Troy neighbor, **Russell Sage College,** a liberal arts school for girls, the girls will live at Russell Sage and study at Rensselaer. Successful candidates will take all academic work at Rensselaer and their academic status will be entirely under the direction and control of the Rensselaer faculty.

Research in sewage filtration .....

A **New York University** research project in controlled sewage filtration, now in its sixth year, has received a $28,060 grant from the U.S. Pubic Health Service. Using principles they themselves established such as deep filter packing of metal and plastic, in addition to the usual stone, NYU engineers have been able to achieve satisfactory filtration at up to 30 times the conventional rate. Because it requires little space and can rehabilitate an over-loaded conventional sewage plant, both industry and municipalities can profit by adding controlled filtration to their waste treatment processes.

Grants to strengthen engineering education .....

A series of grants, totaling $3,110,000, to strengthen and expand engineering education at the doctoral level in Southern universities have been earmarked for the **University of Florida** ($695,000), the **Georgia Institute of Technology** ($680,000), **North Carolina State College** ($760,000), and the **University of Texas** ($975,000). After an initial three-year period, future payment from the Foundation will depend on how much the institution has increased its own expenditures for faculty development and graduate fellowships from normal and continuing sources of support. These increases will be matched by Ford on a one-to-one basis up to a specified amount.

The **National Science Foundation** has awarded grants totaling $9.8 million, to 43 colleges and universities, to support Academic Year Institutes for science and mathematics teachers—the sixth year of this program. The purpose is to help teachers improve their subject matter knowledge through a year's advanced study on a full-time basis. Special emphasis is placed on new developments. Some 1,500 experienced junior and senior high school teachers will attend.

Bucknell gets new lab .....

In conjunction with the Bituminous Concrete Highway Conference, held on November 17 at the **Bucknell University** car pus in Lewisburg, Pa., Bucknell dedicated its new bituminous laboratory. The laboratory was made possible by members of the Bituminous Concrete Association of Pennsylvania, co-sponsors of the conference with the University's department of civil engineering.

Films in the classroom .....

A filmed engineering course designed to teach the use of logarithms and the slide rule are available for use in colleges and junior colleges and, possibly high school classes. The course can also be used for educational television. The series, consisting of 21 films and including student manuals such as lecture notes and problems, as well as a teacher's manual, is designed to present factual material efficiently and effectively to large numbers of students. Inquire at the Bureau of Audio-Visual Instruction, Extension Division, State University of Iowa, 10 Old Capitol, Iowa City, Iowa.

Surveying, mapping, photogrammetry ..

As for the past 40 years, the **Georgia Institute of Technology** and the Georgia Association of Registered Land Surveyors will sponsor the Twentieth Biennial Mapping and Surveying Short Course, January 26-28, 1961. The theme for the 1961 meeting will be the importance of surveying, mapping and photogrammetry in the space age. The lectures and manufacturers' displays will be held in the Architecture Auditorium and exhibition area on the Georgia Tech campus.

In response to requests throughout the United States and Canada, **Cornell University** will offer a two-week intensive course, January 23 to February 3, in the uses of aerial photography. Although the course is designed primarily for practicing engineers and scientists who have little previous training in the field, it is desirable for applicants to have at least a bachelor's degree in a scientific or engineering discipline. In addition to Professor Arthur J. McNair, F. ASCE, who will instruct in photogrammetry, and Professors Donald J. Belcher and Ta Liang, instructors in photointerpretation, outstanding guests will preside over additional lectures and seminars.

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This new catalog has been prepared especially for the use of engineers and contractors who are, or may be, engaged on projects where ground water is a problem.

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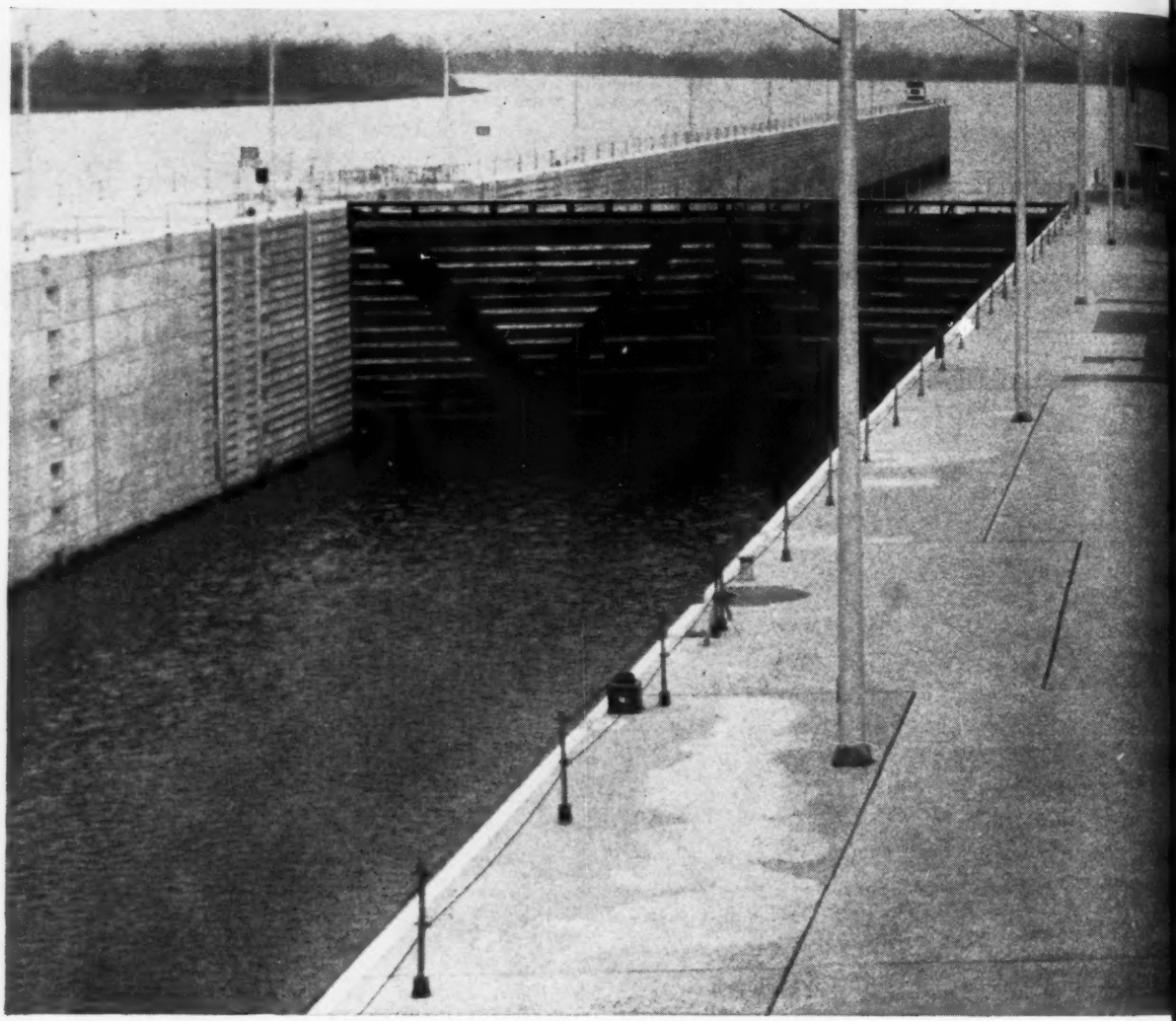


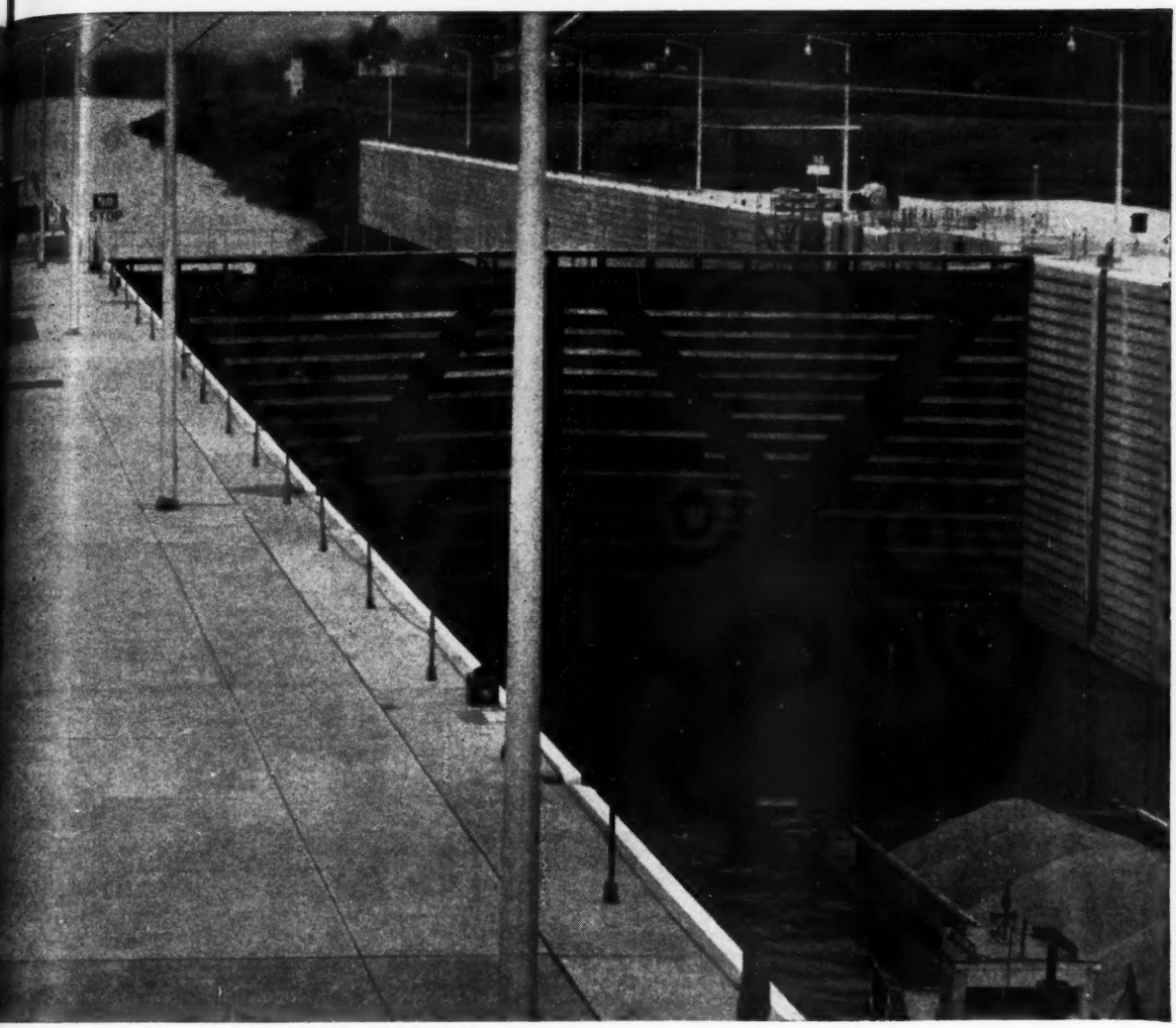
USS "T-1" Steel saves 289 tons

This is a story about how the tremendous strength of USS "T-1" Steel was utilized to save 289 tons of weight in the lock gates at the new Greenup, Kentucky and Markland, Indiana locks and dams on the Ohio River. Each lock gate has five diagonal braces that were designed for USS "T-1" Constructional Alloy Steel. At Greenup, it was estimated that 64 tons of "T-1" Steel did the work of 213 tons of carbon steel in eight gates. At Markland, shown in the picture above, 60 tons of "T-1" Steel were used instead of 200 tons of carbon steel to do the same job.

The diagonal units provide the supports which are absolutely essential to brace the gates. Each diagonal is a flat bar 8 inches wide by 1½ inches thick and about 73 feet long and weighs around 3,200 pounds. Toward the center of the diagonal is a turnbuckle used to adjust tension. By using USS "T-1" Steel, which has a minimum yield strength of 100,000 psi, both the size and weight of the diagonals were greatly reduced while retaining an ample factor of safety.

Lower costs. Reduction in weight because of the use of USS "T-1" Steel meant lower overall material costs, reduced shipping costs by more than one third and decreased handling and erection costs.

Greenup & Markland Lock and Dam Construction: Supervised by Huntington and Louisville District, United States Army Corps of Engineers



# of weight in 16 lock gates

USS "T-1" Steel for hoists. Four hoists for the emergency gates at Greenup locks and dam were also built of USS "T-1" Steel by McNally Pittsburg Mfg. Co., Pittsburg, Kansas. The structures are girder sections about 25 feet long and 41 inches deep. Flanges are 20 inches wide by 2½ inches thick. The webs are 36 inches deep by 1¼ inches thick. All were fabricated from "T-1" Steel plates. Each girder weighs about 12,000 pounds.

The new locks and dam on the Ohio River at Greenup, Kentucky were built under supervision of Huntington, W. Va. District, U. S. Army Corps of Engineers. A similar set of locks at Markland, Indiana was built under the Louisville District, U. S. Army Corps of Engineers.

Other uses of USS "T-1" Steel in construction. Wherever great strength is needed with least weight, such as in bridges, TV towers, pressure vessels, and high pressure penstocks, USS "T-1" Steel is unsurpassed because of its high yield strength, high resistance to impact abrasion, and weldability. For complete information write for our "T-1" book. United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania. *USS and "T-1" are registered trademarks*

Watch United States Steel's special Christmas show, **The Coming of Christ,** in Color on NBC-TV, Wednesday, December 21, 8:30 P.M., E.S.T.

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News of Members

(Continued from page 28)

James S. Sweet, hydraulic engineer with the U.S. Weather Bureau in Washington, D. C., recently represented the World Meteorological Organization of Geneva, Switzerland, in the negotiations with the Peruvian Government at Lima, on the plan for a hydrometeorological project. The project, expected to take four years, will be financed by the United Nations Special Fund, and involves the establishment of hydrologic and meteorological networks, and a hydraulic laboratory.

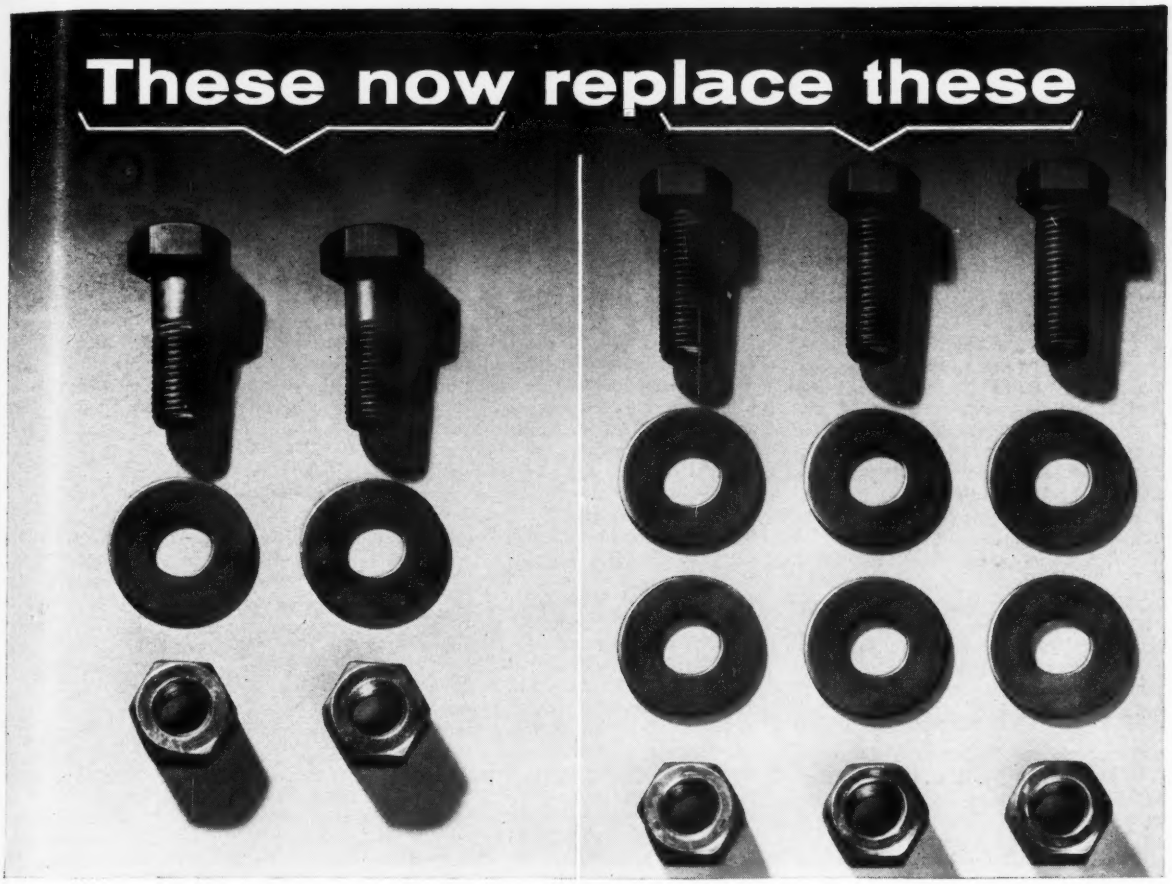
Shu Magota, advanced from acting director to director of engineering at Daniel, Mann, Johnson, and Mendenhall, Los Angeles architects and engineers, will be responsible for the over-all activities of the DMJM departments of engineering. He has been with the firm for twelve years. In other organizational changes **David R. Miller,** a veteran of eight years service with DMJM and most recently project manager for the firm's mass rapid transit study undertaken for the Los Angeles Metropolitan Transit Authority, will take on additional duties as chief engineer for the firm's International Division, while **Philip M. Linscott,** who served as project engineer, has been named chief transportation engineer and assigned to the firm's traffic and transportation work. **James Reiter,** formerly a project engineer in the Civil Engineering Section, is now chief civil engineer.

William S. Pollard, Jr., with Harland Bartholomew and Associates for six years, and a partner for three years, has direction of the firm's newly established Memphis (Tenn.) office at 188 Jefferson Avenue. Currently, his most important responsibility is the design of 60 miles of urban interstate highways in Memphis and Shelby County, Tenn.

John M. Kyle, Jr., received the "Award in Engineering" at the recent annual dinner of the New York Chapter of the New York State Society of Professional Engineers. As chief engineer of the Port of New York Authority since 1947, Mr. Kyle has been in charge of the design and construction of all Port Authority work.

William A. Keane was appointed a research assistant in the school of engineering at Manhattan College, Riverdale, N. Y., recently. Mr. Keane, who is an alumnus of Manhattan College High School and Manhattan College, will assist with research projects in the department of civil engineering.

Robert V. Lord, Jr., of Boulder, Colo., has purchased the facilities and equipment of the Boulder branch office of Western Laboratories, Inc. Mr. Lord, who opened the office for Western Laboratories in 1957, and has served as its manager since that time, will continue intact the staff and facilities under the firm name R. V. Lord & Associates, Inc.



How you can cut structural steel costs with new design RB&W High Strength Bolts

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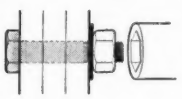

This sketch shows why. The new bolt has shorter thread length. Shear planes pass through full shank section only, thereby enabling the full, allowable shear strength of the bolt to be utilized. The new larger head furnishes extra bearing area to prevent crushing when bolt is torqued up to its full recommended tension. Only one washer is needed . . . under head or nut whichever is rotated in wrenching.

The AISC approves this fastening breakthrough. It has been fully tested and approved by the Research Council on Riveted and Bolted Structural Joints. The sooner that structural engineers work it into their new designs, the sooner everybody benefits. Building owners benefit through lower costs; construction shop fabricators benefit through more tonnage assembled faster with existing shop space; erectors benefit through fewer holes to fill and less material cost.

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DECEASED

Donald McCord Baker (M. '29; F. '59), age 69, pioneer in the field of water supply and transportation in the southwestern states, died on October 1 in Los Angeles, Calif. Mr. Baker had a consulting practice in Los Angeles from 1924 until his death—from 1942 until 1954 as a partner in Ruscardon Engineers. He had served as consultant to such agencies as the Los Angeles Flood Control District, the Long Beach (Calif.) Water Department and the Water Resources Committee of the National Resources Planning Board, and had been president of the Los Angeles City Planning Commission. He was author of many works on water supply, including the groundwater section of the ASCE Hydrology Manual. Mr. Baker had been president of the Los Angeles Section.

Edwin W. Burritt (M. '35; F. '59), age 72, who retired three years ago as a member of Baltimore Contractors, Inc., died recently in Baltimore, Md. Mr. Burritt was associated with the company as a civil engineer and consultant over a twelve-year period.

Sergio Cuevas Bustamante (M. '49; F. '59), age 62, public official, civil engineer and consultant, died recently in San Juan, Puerto Rico. His long public service career included an executive position with the Guayama Irrigation District. He had also been Secretary of the Interior, and was founder and first director of the Puerto Rico Aqueduct and Sewer Authority. After his retirement from government service in 1954 he was an associate engineer with the firm of consulting engineers, Buck, Seifert and Jost, and just recently he had accepted the vice presidency of the Rexach Construction Company.

Frank H. Conley (A.M. '35; M. '59), age 55, for the past 15 years co-owner and manager of the Red River Construction Company, Shreveport, La., died there recently. Earlier Mr. Conley was an engineer with the Tennessee Valley Authority, and in charge of production oil properties in northern Louisiana for the Mercantile National Bank, of Dallas. During World War II he served in the Corps of Engineers, rising to the rank of major.

William P. Cottingham (M. '26; F. '59), age 73, who played a major role in the development of Gary, Ind., as city engineer from 1918 to 1935, died recently in Gary. He was executive secretary of the Gary Chamber of Commerce from 1944 until 1954 and executive secretary of the Gary Industrial Foundation from 1954 until his retirement last year. He had also been a member of the Gary Board of Sanitary Commissioners.

James William Cross (A.M. '59; M. '59), age 34, for the past six years a civil engineer with the U.S. Bureau of Reclamation in Ogden, Utah, died there recently. In his early career Mr. Cross served as a civil engineer assistant in the construction division of the Los Angeles County Road Department. He was a 1953 civil engineering graduate of the University of Wyoming.

Anthony J. Daino (A.M. '20; M. '59), age 70, retired consulting engineer of Wappinger Falls, N. Y., died there recently. For many years Mr. Daino was assistant engineer with the Public Service Commission in New York, specializing in subway construction. He then joined the Slattery Engineering and Construction Company, which later became the Slattery-Daino Company. Following the death of his partner Mr. Daino founded the A. J. Daino Construction Company in Coral Gables, Fla.

John Bowen Dean (M. '27; F. '59), age 73, division engineer for the St. Louis (Mo.) Water Department, died in that city recently. He had been associated with the Water Department for forty years, and was water commissioner from 1935 to 1941. His previous experience included acting engineer of the St. Louis Sewer Department; resident engineer on railroad construction in the West; and chief fuel chemist and inspector of materials for the U.S. War Department.

Robert C. Dennett (M. '36; F. '59), age 80, who retired in 1954 as assistant chief engineer of the National Board of Fire Underwriters, died recently at his summer home at Wayne, Me. In 50 years of continuous service to the organization, he had been field engineer, office engineer and assistant chief engineer, and had surveyed the water supply systems of 150 major U.S. cities.

Roy V. Engstrom (M. '22; F. '59), age 78, chairman of the board of Engstrom & Wynn, Inc., general contractors with offices in Wheeling, W. Va., died in that city on October 12. In 1922 he left his position as district manager of Stone & Webster in Chicago to join J. W. Wynn, now deceased, in founding Engstrom & Wynn.

Edgar Eugene Foster (M. '47; F. '59), age 67, retired civil engineer and specialist in hydrology, died recently in San Francisco, Calif. Mr. Foster was an associate engineer with the U. S. Corps of Engineers from 1924 to 1944, and from 1946 to 1953 was with the U. S. Bureau of Reclamation at Denver, Colo. For five years, prior to his retirement in 1958, Mr. Foster maintained a consulting office in Wheatridge, Colo., and was employed during that time on several foreign projects. He was the author of *Rainfall and Runoff*.

Carl B. Gerber (M. '58; F. '59), age 55, originator of the use of rigid frames for heavy military construction and designer of the structure of the dome of the National Gallery of Art in Washington, died recently in Providence, R. I. In the course of a long career with the Army Corps of Engineers, 1932 to 1958, Mr. Gerber participated in the structural design of many public buildings in the Washington area. He had been in private practice in Arlington, Va., since 1958.

Henry Gutman (M. 34; F. '59), age 73, for the past 14 years a consulting engineer in San Diego, Calif., died there recently. Early in his career Mr. Gutman was employed by the Trussed Concrete Steel Company as a designer, and later was in charge of the company's engineering department. For a number of years he was a designer in the bridge department of the Delaware, Lackawanna and Western Railroad Company.

Stanley Hargen (A.M. '28; M. '59), age 71, retired engineer of the Socony Vacuum Oil Company, New York, N. Y., died recently at Babylon, N. Y. In his early career Mr. Hargen was a topographer with the U.S. Geological Survey. In 1919 he joined the Standard Oil Company of New York where he remained as assistant to the chief engineer until 1935. In the latter year he went to the Socony Vacuum Oil Company as an engineer, becoming assistant chief engineer four years later.

Charles A. Holden (M. '24; F. '59), age 88, former dean of Dartmouth College's Thayer School of Civil Engineering, died in Concord, N. H., on October 12. He was on the Dartmouth engineering faculty from 1901 until he retired as dean in 1937. He also found time for other activities, including service as a New Hampshire state engineer from 1916 to 1937, on problems connected with the New Hampshire-Vermont boundary and as a member of the state's House of Representatives for a number of years.

Harry Northrop Howe (M. '41; F. '59), age 78, partner in Gardner & Howe, Memphis, Tenn., died there on October 3. Following the death of his partner William Gardner in 1930, Mr. Howe continued as sole owner of the firm until 1949 when it became a partnership owned by him and his son, Warner Howe, M. ASCE. In his long tenure with the firm Mr. Howe had become widely known as a designer of concrete and steel buildings. He was honored by the Tennessee State Board of Architectural and Engineering Examiners for outstanding service on the board, 1951-1959, and was chosen "Engineer of the

(Continued on page 106)

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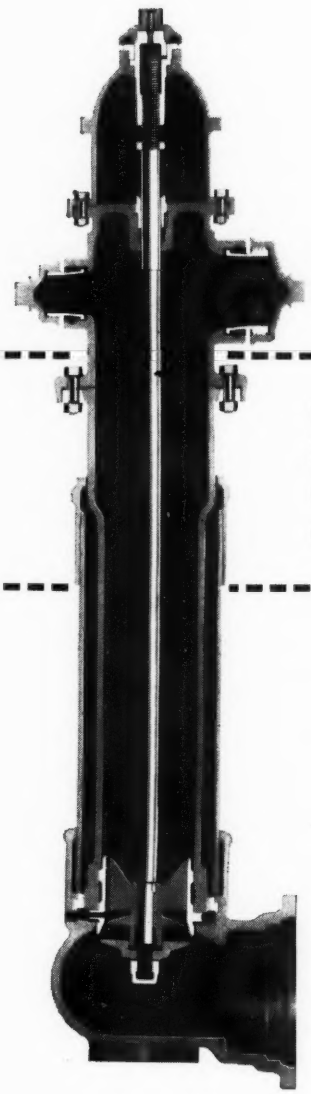

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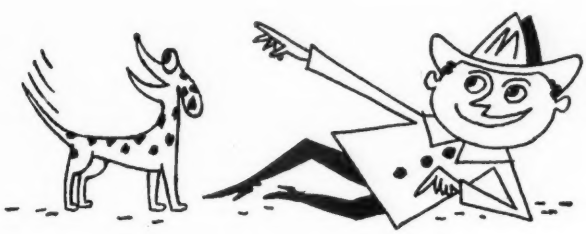

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Deceased

(Continued from page 104)

Year" in 1957 by the Memphis Chapter of the Tennessee Society of Professional Engineers. He was a past president of the Mid-South Section.

James E. McDonald (A.M. '44; M. '59), age 55, for the past 16 years owner and operator of the Knoxville, Tenn., engineering firm bearing his name, died in that city on October 12. His projects included design of the West Knoxville water supply system, completed about four years ago, and the recently completed Northeast Knoxville Utility District's water treatment plant on the Holston River. Before opening his own firm, Mr. McDonald was employed by the Stone & Webster Engineering Company laying out water and sewer lines during the building of Oak Ridge.

William Henry Mead (M. '34; F. '59) age 72, consulting engineer of Luling, Tex., since 1950, died there recently. For eleven years Mr. Mead was employed by the Texas Company as field engineer in the pipeline department and later as chief engineer in the production department. He had also served as chief engineer of the American Petroleum Company; as chief engineer and general superintendent of the Salt Flat Water Company; and as supervisory engineer and district superintendent of War Emergency Pipe Line, Inc.

Frederick G. Merckel (A.M. '21; M. '59), age 64, director and retired president of Wallace & Tiernan, Inc., of Belleville, N. J., died in London, England, on October 29. Mr. Merckel joined Wallace & Tiernan in 1921 and, in the same year, was sent to Shanghai to supervise the installation of a new water filtration plant. Upon his return to the United States, he was made manager of the Chicago office. In 1954 when Wallace & Tiernan became a public owned company he was elected president. At the time of his death, Mr. Merckel was in England on a trip for the firm.

Cecil Durward Miller (M. '55; F. '59), age 60, district engineer for the Asphalt Institute at Oklahoma City, Okla., died there recently. From 1921 to 1927 Mr. Miller was with Black and Veatch in a variety of capacities, and from 1929 to 1943 was field engineer with the Portland Cement Association in Kansas City, Mo., and Oklahoma City. More recently he had been salesman and engineer with the Ideal Cement Company and district engineer with the Clay Products Association.

Raymond Willis Murphy (M. '40; F. '59), age 57, city engineer of Rye, N. Y., since 1942, died in Port Chester, N. Y., on October 15. Earlier he had served for five years as assistant village manager of Rye, and from 1933 to 1942 was with the U.S. Bureau of Indian Affairs in Montana. Since 1945, in addition to his duties as city engineer, Mr Murphy had also practiced as a consulting engineer.

James Newton Ritchey (A.M. '58; M. '59), age 43, for the past two years civil engineer with Sweet Associates, Inc., of Schenectady, N. Y., died in that city recently. Mr. Ritchey's earlier experience included ten years as structural design engineer, chief field engineer, and chief draftsman with Sanderson & Porter Engineers, and two years as senior draftsman with Glenn L. Martin, Baltimore.

Dan D. Robertson (A.M. '47; M. '59), age 49, owner of the Lindley Construction Company in Scottsdale, Ariz., died there recently. For ten years prior to 1958, when he took complete charge of the company, Mr. Robertson was a partner in the firm with offices in Atherton, Calif. His earlier experience included employment as an engineer with the Soule Steel Company in San Francisco.

George Roberg Thompson (M. '37; F. '59), age 75, retired civil engineer and former city engineer of Detroit, Mich., died recently in Royal Oak, Mich. Mr. Thompson was budget director for the State of Michigan for most of the 1927-1937 decade. His service to the city of Detroit included terms as chief building inspector and superintendent in the department of public works. He was city engineer from 1937 to 1954, when he joined the architect-engineer firm of Giffels and Rossetti. He retired last January.

Harry C. Vensano (M. '14; F. '59), age 78, former San Francisco director of public works and works chief for the San Francisco World's Fair, died in Los Gatos, Calif., on October 6. For 10 years Mr. Vensano was head of the Pacific Gas & Electric Company's civil engineering department. Starting in 1936, he was successively chief of construction, assistant works director, and director of works for the fair. He was San Francisco director of public works from 1942 until 1950. As head of H. C. Vensano & Company, he built 17 dams and three Sacramento River pumping plants.

Carlile P. Winslow (A.M. '10; M. '59), age 76, retired civil engineer and pioneer in the field of wood research, died recently in Washington, D. C., where he had lived since 1947. From 1917 to 1946 Mr. Winslow was director of the U.S. Forest Products Laboratory at Madison, Wis., which he helped organize. His many developments in the field of forest products included waterproof glues and woods used for airplanes, and an all-wood prefabricated system of house construction that is widely used. One of his major concerns was the development of methods for reducing waste in all forest products industries. Recognition of his leadership in the field of wood research brought him many honors.

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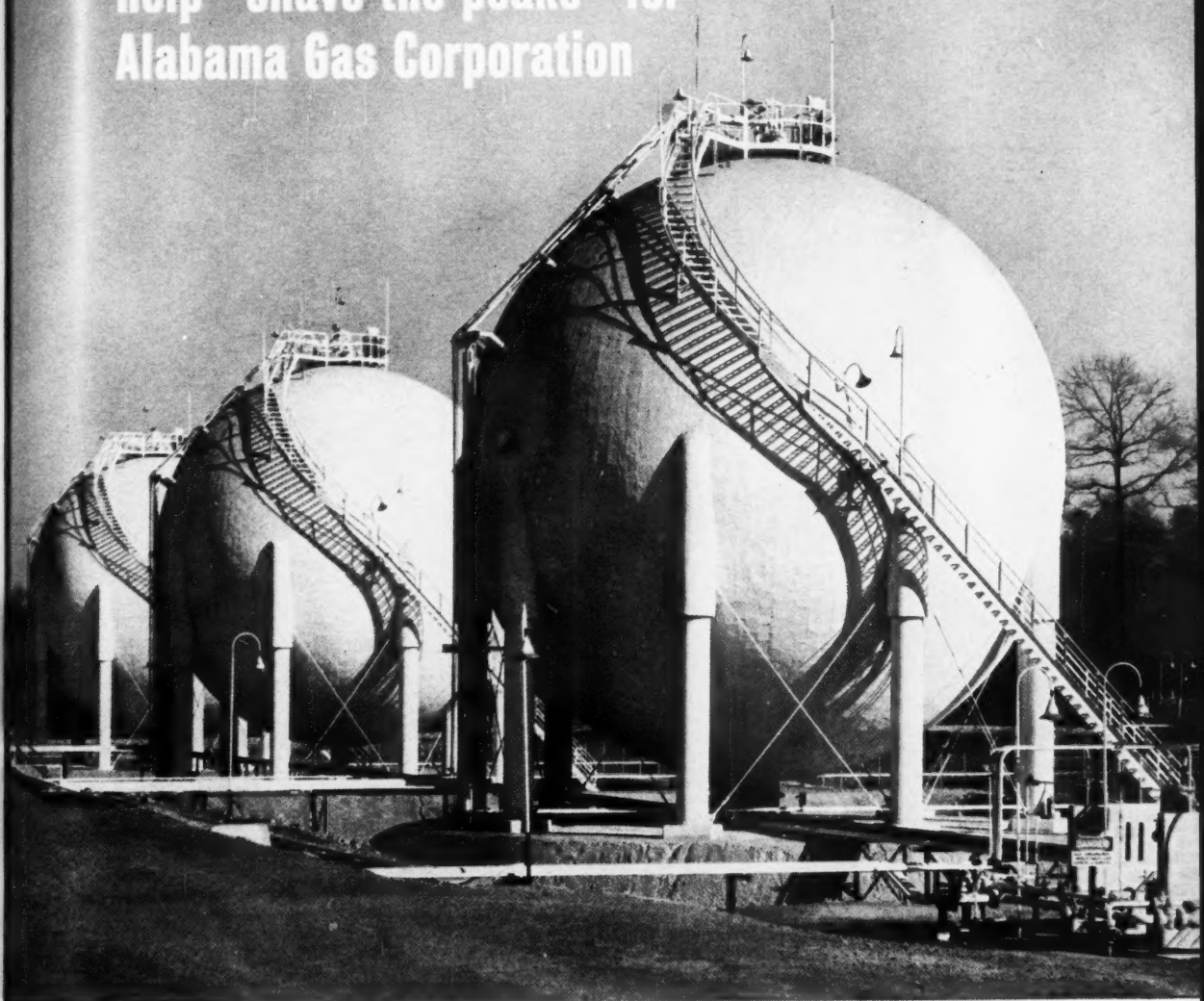

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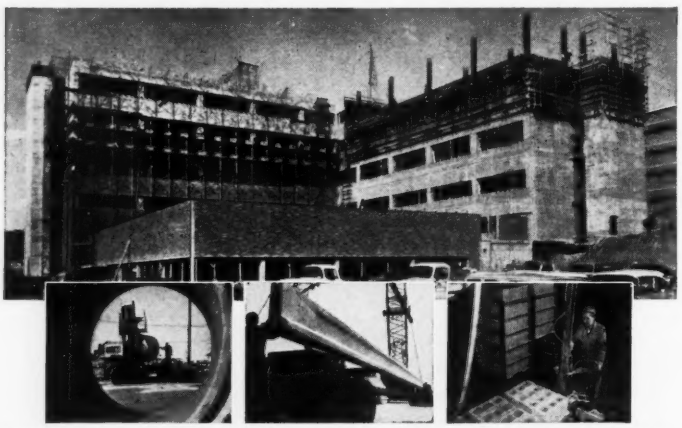

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Applied Engineering Mechanics
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A simplified approach explaining the basic concepts of engineering mechanics and their application in the solution of a wide variety of engineering problems. Thoroughly revised, this edition includes new material on statics, including sections on belt friction, the forces produced by hydrostatic loads, and in suspension cables and arches, and the stability of retaining walls, and new material on dynamics, including expanded treatment of noncentroidal rotation, and sections on dynamic equilibrium of plane motion, direct central impact, conservation of linear momentum, and angular impulse-momentum relationships in rotation and plane motion problems. (By Alfred Jensen. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1960. 409 pp., bound. $6.50.)

Air Pollution Manual
Part 1: Evaluation

Prepared by specialists in the field of industrial hygiene and air pollution, this book presents information needed for the intelligent appraisal of air pollution problems. It is a practical book, containing discussions of the methods, techniques, and instrumentation relevant to investigations of each problem, as well as literature references to proven sources of information. Volume 2 to follow, dealing with air pollution control. (Published by the American Industrial Hygiene Association, 1425 Prevost, Detroit, Mich., 1960. 194 pp., bound. $8.50.)

Concrete and Soil-Cement Roads

This is a summary of British advances in the design and construction of concrete roads, and of concrete, lean concrete and soil-cement bases for asphalt coverings, together with experience with these forms of construction in other countries. It also includes details of special methods, such as prestressed concrete, and of roads for special purposes, such as concrete farm roads, and gives information about concrete curbs and the maintenance and repair of concrete roads. (By W. P. Andrews. Contractors Record Ltd., London, England, 1960. 157 pp., bound. 30s.)

Concrete Formwork Designer's Handbook

Deals only with the structural design of formwork, and is applicable to timber, plywood and steel, illustrating the more common arrangements of members in considering examples of loading through simplified formulae and nomograms. Full information is given on the pressures exerted by concrete. (By H. R. Gill. Concrete Publications Ltd., London, England, 1960. 153 pp., bound. $3.50.)

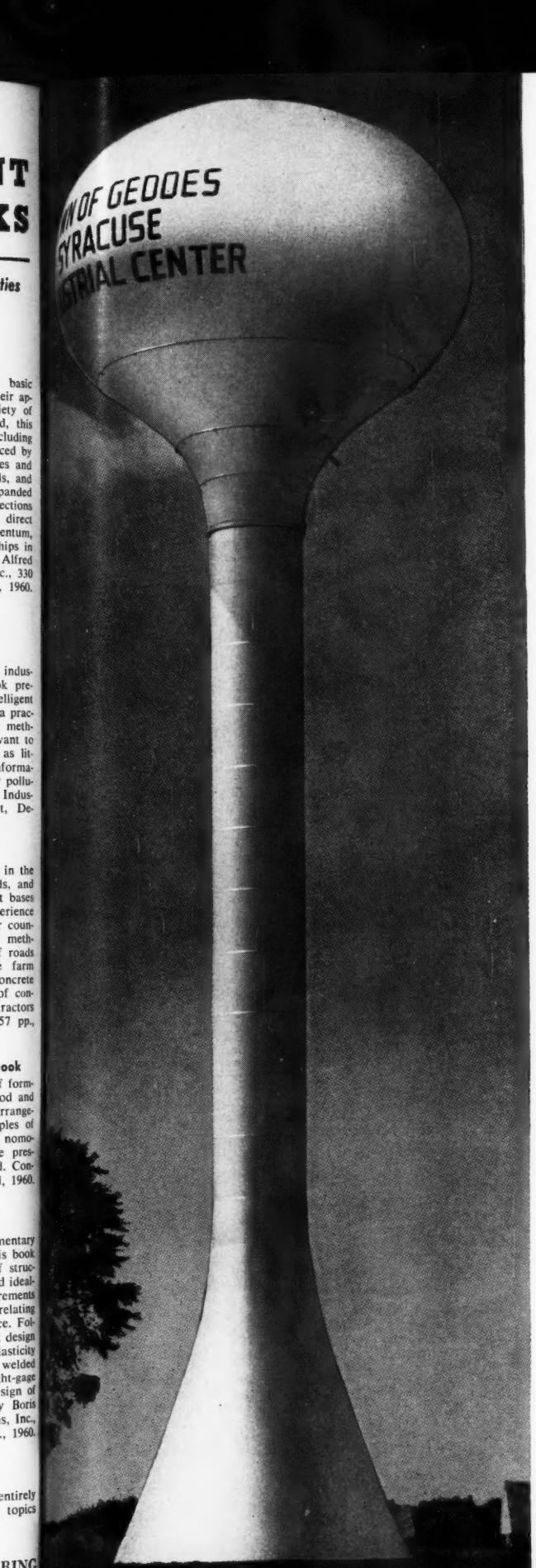
Design of Steel Structures

Intended as a textbook in both elementary and advanced civil engineering courses this book emphasizes the fundamental principles of structural mechanics, the behavior of actual and idealized structures, and such practical requirements as safety, feasibility, and economy, correlating these concepts with current design practice. Following a general introduction to structural design principles, the book covers elasticity, plasticity and safety, riveted, bolted, pinned and welded connections, tension compression and light-gage members, beams and girders, and the design of steel bridges and of steel buildings. (By Boris Bresler and T. Y. Lin. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1960. 710 pp., bound. $9.75.)

Engineering Analysis

This is a treatment of mathematics entirely from the engineer's point of view. The topics

(Continued on page 110)



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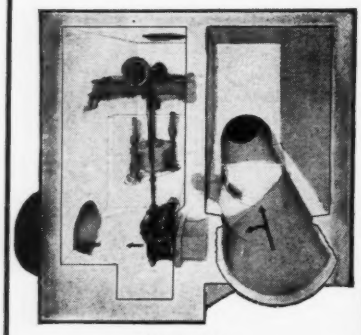

Fig. B-19

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Recent Books

(Continued from page 108)

covered are applications of integral and of differential calculus, vector algebra, ordinary differential equations, and the Fourier series. Numerical and graphic methods are given, emphasizing precision of results. Worked-out solutions are given for some problems, and answers are given for all. (By Wen-Hsiung Li. Prentice-Hall, Inc., Englewood Cliffs, N. J., 1960. 362 pp., bound. $8.25.)

Elementary Structural Analysis
Second Edition

This new edition reflects advances since 1948 in fabrication and construction techniques which have led to more efficient or increased use of steel, concrete, wood, and aluminum. Four major units have been added—an historical introduction, an introduction to matrix analysis, a discussion of aspects of the plastic behavior of structures, and an introduction to advanced structural mechanics. Does not touch on structural design at all. (By Charles Head Norris and John Benson Wilbur. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1960. 651 pp., bound. $10.50.)

From Theory to Practice in Soil Mechanics; Selections from the writing of Karl Terzaghi.

A detailed account of the personality, professional achievements and method of working of Karl Terzaghi, composed mainly of his own words through selection from his writings, with some explanatory comment. Clearly demonstrated in this manner is the way in which he established the fundamental principles of soil mechanics and then used them as powerful tools in his engineering practice. Also included is a bibliography, and contributions describing his life, achievements, and their significance. (By L. Bjerrum and others. John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y., 1960. 425 pp., bound. $12.00.)

Manual of Photographic Interpretation

The material in this manual is arranged in sections, each compiled and edited by various experts in the field. These sections cover the means of obtaining photographs, principally aerial, for the purpose of photo-interpretation; the development, fundamentals and special forms of photo-interpretation; the application of photo-interpretation in geology, soil mechanics, engineering, forestry, wild life and range management, hydrology, agriculture, urban area analysis, archaeology and geography. The final chapter is devoted to an examination of the education and training for photo-interpretation, and includes a résumé of training offered in various parts of the world. (Published by the American Society of Photogrammetry, 1515 Massachusetts Avenue, N. W., Washington 5, D. C., 1960. 868 pp., bound. $12.50.)

McGraw-Hill Encyclopedia of Science and Technology
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The more than six million words, and approximately 10,000 illustrations, drawings, charts, tables etc. in this unique set of 15 volumes are grouped under some 7,200 subject headings of moderate scope to bring together closely related subject matter. Numerous cross-references refer to other related sections. A detailed subject index of more than 100,000 entries occupies 434 pages of volume 15, which also identifies members of the Editorial Advisory Board, the 63 consulting editors, and the 2,100 contributors who wrote material in the set.

All fields of science and technology are covered on a level generally suitable for undergraduate college students, and for the serious-minded layman and some high school students especially interested in science and technology. It is not likely to appreciably help any engineer or scientist in his own special field, but it should often be useful to him as a ready reference source of information in other fields with which he is less familiar. All sciences—life, physical, and earth—are covered, as are major applications in technology and engineering in the basic fields such as chemical, civil, electrical, mechanical, metallurgical, mining, and petroleum, and their various branches. Bibliographical references are given for many subjects. (Edited by William H. Crouse and others. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y., 1960, bound. $175.00.)

Methods and Techniques in Geophysics
Volume I

A collection of papers dealing with modern physical techniques employed in determining and dealing with physical information about the earth. Contributors from the U. S., Canada, and Britain discuss measurement of temperature gradient in the earth, heat flow over land, geomagnetic elements, gravity at sea, and in palaeomagnetism; earth currents and the detection of earth movements; borehole surveying; properties of rock under high temperature and pressure; and the latitude, longitude, and secular motion of the pole. (Edited by S. K. Runcorn. Interscience Publishers, Inc., 250 Fifth Avenue, New York 1, N. Y., 1960. 374 pp., bound. $10.00.)

Library Services

Engineering Societies Library books, except bibliographies, handbooks, and other reference publications, may be borrowed by mail by ASCE members for a small handling charge. The Library also prepares bibliographies, maintains search and translation services, and can supply a photoprint or a microfilm copy of any items in its collection. Address inquiries to R. H. Phelps, Director, Engineering Societies Library, 29 West 39th Street, New York 18, N. Y.

Metropolis and Region

This volume aims to depict a system of metropolitan communities as it was functioning at about the middle of the twentieth century. It embodies regional studies by Resources for the Future, Incorporated, and the authors are connected with the Population Research and Training Center, University of Chicago. The four major sections of the book deal with the metropolis and its functions; metropolitan dominance and hinterland activities; industry structure and regional relationships; and a study of fifty major cities and their regional relationships. (By Otis Dudley Duncan and others. The Johns Hopkins Press, Homewood, Baltimore 18, Md., 1960. 587 pp., bound. $8.50.)

The Story of Engineering

An outstanding writer on the history of engineering presents here the history of the works of the master builders of the Western world, from the early Egyptians to the leaders of 20th century engineering. It is the account of the great construction works of man—bridges and roads, dams and canals, mines and machines—as well as the modern discoveries in such fields as electrical and chemical engineering, told in terms of individual engineers who contributed to these fields of endeavor. (By James Kip Finch. Doubleday & Company, Inc., Garden City, N. Y., 1960. Paper. $1.45.)

Waste Treatment, Proceedings of the Second Symposium on the Treatment of Waste Waters, 1959

This symposium held at Newcastle upon Tyne, concentrated on the theory and practice of biological waste treatment on the disposal of solids removed from liquid wastes. The introductory section contains four papers dealing with the bio-chemistry of serobic and nonserobic waste treatment, the ecology of activated sludge and bacteria beds, and manometric methods in the study of wastes. Then follow five papers dealing with biological treatment practice, four dealing with the sampling and analysis of waste water and other trade effluents, four covering sludge treatment and composting, and three describing waste treatment in the food canning and freezing, tanning, and milk-product industries. The final paper deals with reclamation of water from domestic and industrial wastes. (Edited by Peter C. G. Isaac. Pergamon Press, Inc., 222 East 55th Street, New York 22, N. Y., 1960. 477 pp., bound. $15.00.)

Sheet-piling breasting dolphins built around prefabricated falsework

Maneuvering of 27,000-ton oil tankers in the Piscataqua River near Portsmouth, N.H., is greatly facilitated by two new breasting dolphins, constructed of steel sheet-piling.

Falsework for the 47.9-ft dolphins was constructed on shore, then floated out to position in the river. The falsework, held firm by H-pile sections, permitted accurate pile-driving and closure of the Bethlehem sheet piling, despite a five-knot current.

After the sheet piling was in place, the cells were partially filled with gravel, and the falsework removed. Then more gravel was added (for a total of 3500 cu yds each) and the dolphins topped with a concrete cap. Each dolphin required 120 Bethlehem SP6A sheet-pile sections, 55 to 57 ft long. Seaboard Construction Company is the contractor for Atlantic Terminal Sales Corporation.

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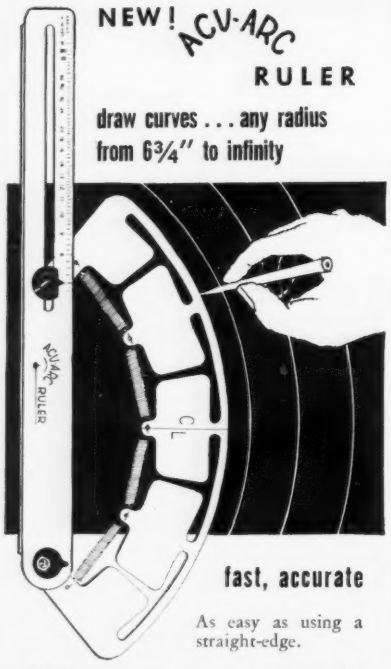

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Non-ASCE Meetings

American Concrete Institute. Fifty-seventh annual convention at the Chase and Park Plaza Hotels, St. Louis, Mo., February 20-23. Apply to William A. Maples, Secretary-Treasurer, ACI, 22400 West Seven Mile Road, P. O. Box 4754, Redford Station, Detroit 19, Mich.

American Institute of Chemical Engineers. National meeting at the Roosevelt Hotel, New Orleans, La., February 26 to March 1. Address inquiries to F. J. Van Antwerpen, Secretary, AICE, 25 West 45th Street, New York 17, N. Y.

FIP-RILEM. Symposium on injection grout for prestressed concrete at Norges Tekniske Hogskole, Trondheim, Norway, January 5-7. For further information contact Professor I. Lyse, NTH, Trondheim, Norway.

Highway Research Board. Annual meeting at the Sheraton-Park Hotel, Washington, D. C., January 9-13. Additional information available from Fred Burggraf, Director, 2101 Constitution Avenue, Washington 25, D. C.

Public Health Service. National Conference on Water Pollution, Washington, D.C., December 12-14. The information unit for the conference is located in Room 4310, HEW Building, South, Department of Health, Education and Welfare, Washington 25, D.C.

University of Illinois. Third Sanitary Engineering Conference on disinfection and chemical oxidation in water and waste treatment, sponsored jointly by the Department of Civil Engineering and the Division of Sanitary Engineering of the Illinois Department of Public Health on the University's campus at Urbana, January 31 and February 1. Ben B. Ewing, Associate Professor of Sanitary Engineering, University of Illinois, Urbana, or C. W. Klassen, Chief Sanitary Engineer, Department of Public Health, Springfield, Ill.

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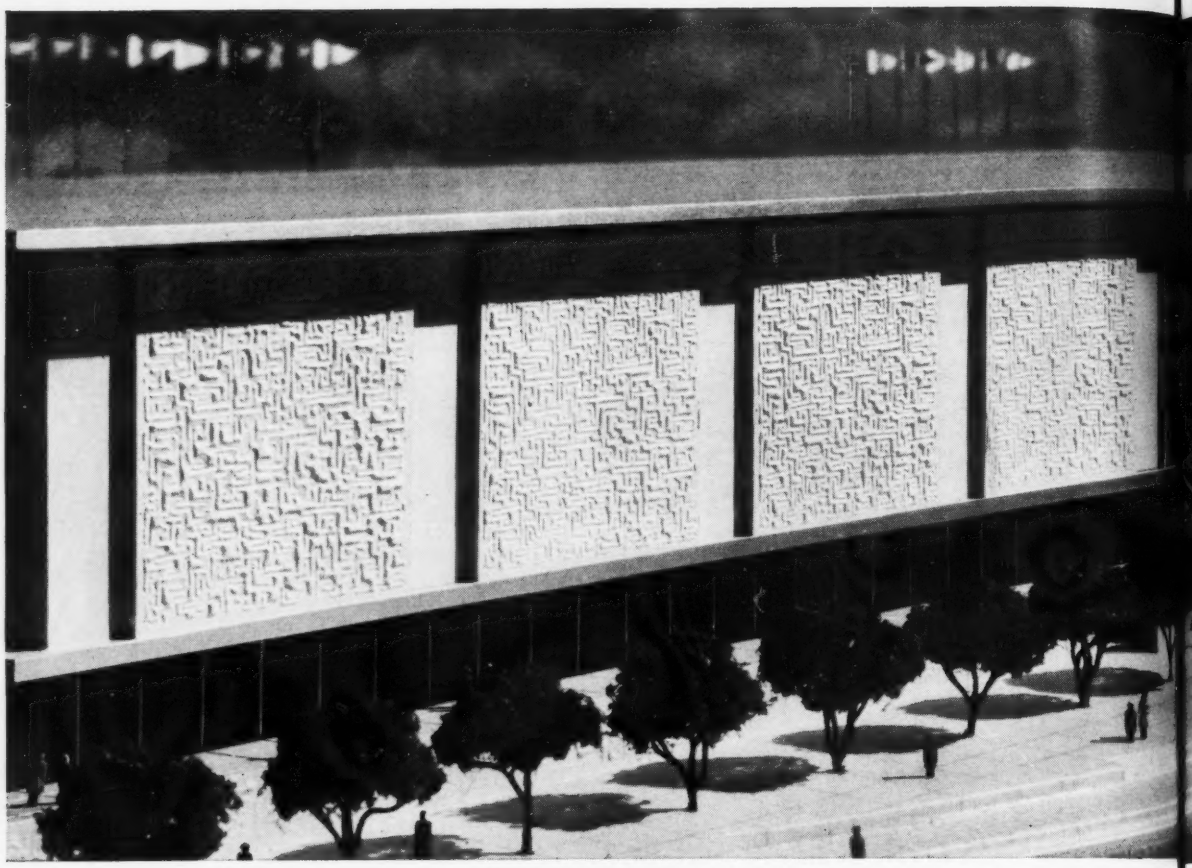


Steel Fabric reinforces sculptured precast concrete panels

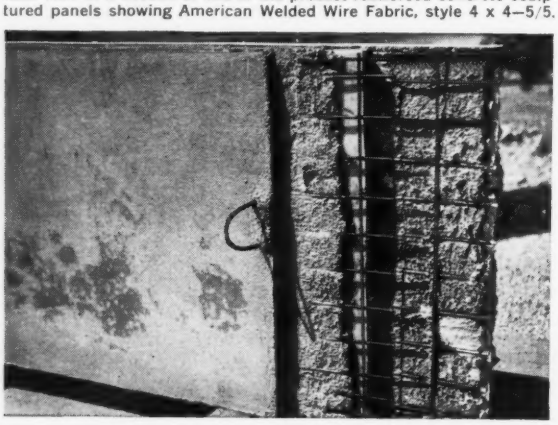
Chicago's new Convention and Exposition Center gives you a lot to marvel at. For one thing, you could put Wrigley Field, Comiskey Park and Yankee Stadium under its roof. For another, it is spectacularly beautiful from any angle.

But only architects, engineers and contractors will fully appreciate how some of the ingenious structural and architectural effects were achieved. So, look closely at the photographs and don't forget the unusual sculptured panels are of precast concrete reinforced with USS American Welded Wire Fabric.

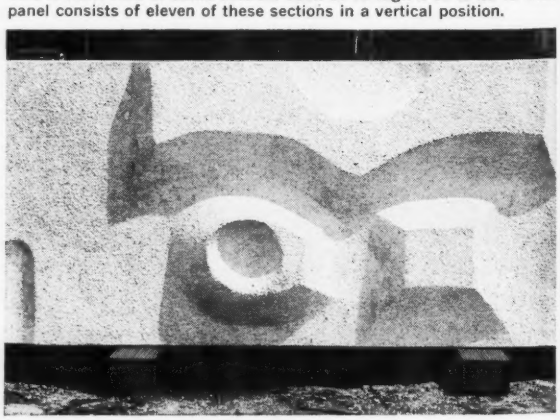
USS American Welded Wire Fabric was also used for concrete reinforcement of the pan-type floor construction. The floor is designed for 400 psi live loads with columns at 60-ft. centers. The joists are 14″ deep with the top 4½″ slab reinforced with welded wire fabric sheets. Welded wire fabric reinforcement was also used in the construction of the ground floor slabs, terrazzo floors and gypsum roof decks.

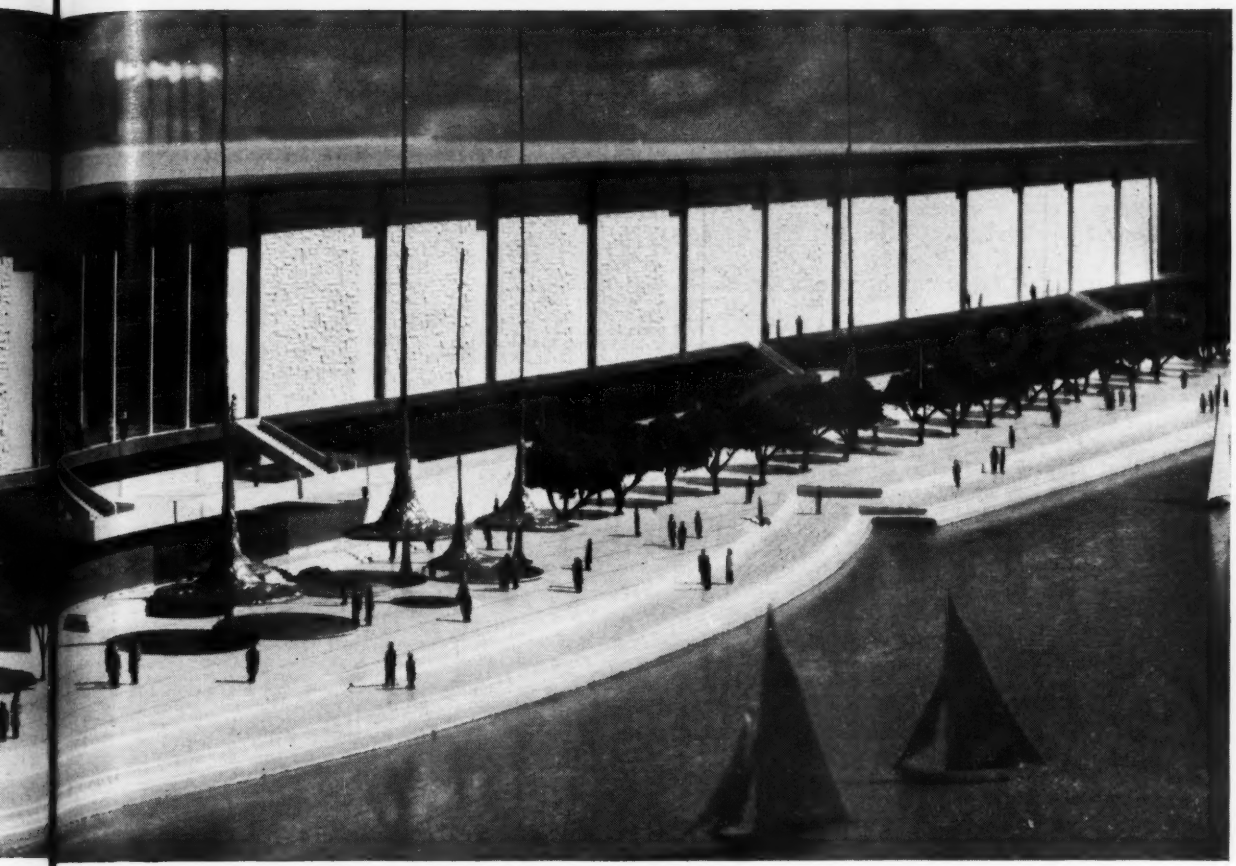
USS American Welded Wire Fabric is readily available in a variety of styles, sizes, lengths, widths and finishes—in wire gauges from 7/0 to 16 and with longitudi-

Rear view of a section of one of the precast reinforced concrete sculptured panels showing American Welded Wire Fabric, style 4 x 4—5/5.



This is front view of same section. Each 50 ft. high x 15 to 20 ft. wide panel consists of eleven of these sections in a vertical position.





in Chicago's McCormick Place Lakefront Exposition Center—

nal or transverse intervals of 2″ to 16″.

For more information on the advantages and applications of USS American Welded Wire Fabric, get in touch with our nearest Sales Office or write American Steel & Wire, Dept. 0479, 614 Superior Ave., N. W., Cleveland 13, Ohio. *USS and American are registered trademarks*

Credits: Chicago's McCormick Place Lakefront Exposition Center—23rd Street and the Lakefront. *Chief Architect:* Alfred Shaw, *Consultants:* Carl A. Metz, John Dolio, Edward D. Stone, John Root, Victor Hofer. *General Contractor:* Gust K. Newberg Construction Co. *Welded Wire Fabric Distributor:* Joseph T. Ryerson & Son, Inc. *Posttensioning Wire Tendons:* Joseph T. Ryerson & Son, Inc. *Precast Wall Panels:* American-Marietta Co., Concrete Products Division.

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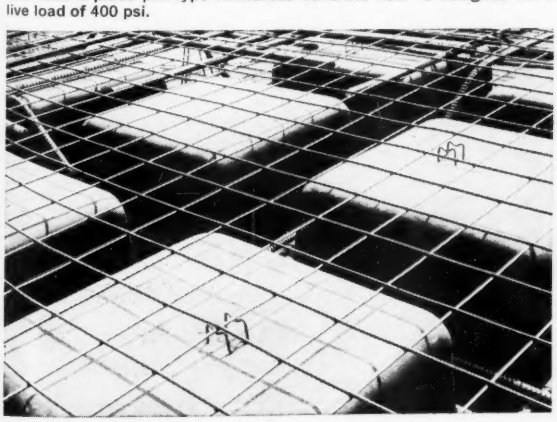
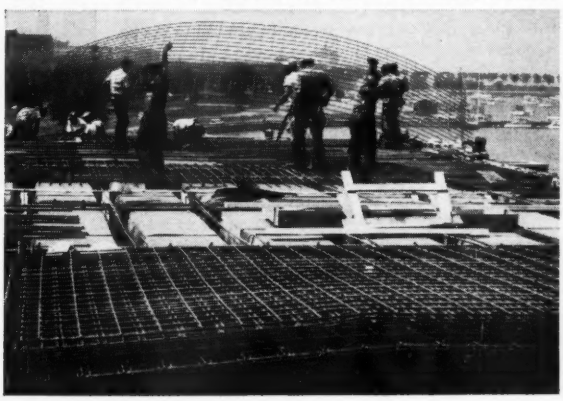
The cast-in-place pan-type reinforced concrete floor is designed for a live load of 400 psi.



Large sheets of USS American Welded Wire Fabric, style 6 x 6—2/2 used to reinforce the 4½″ thick concrete slabs are handled by two men.



ENGINEERING SOCIETIES PERSONNEL SERVICE, INC.

(Agency)

New York 8 W. 40th ST. | **CHICAGO** 29 E. MADISON ST. | **SAN FRANCISCO** 57 POST ST.

These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which cooperates with the national societies of Civil, Electrical, Mechanical, Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or non-members, and is operated on a non-profit basis. If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee of 60 percent of the first month's salary if a non-member, or 50 percent if a member. Also, that you will agree to sign our placement fee agreement which will be mailed to you immediately, by our office, after receiving your application. In sending applications be sure to list the key and job number.

When making application for a position include 8 cents in stamps for forwarding application to the employer and for returning when possible.

Men Available

PROJECT MANAGER OR SENIOR ENGINEER, F. ASCE, civil graduate. Broad experience with consulting engineers on hydro-electric studies and construction supervision, mostly foreign. Now available for foreign service in heavy engineering work for long or short period. Salary, $15,000 a year. C-618.

STRUCTURAL ENGINEER, M. ASCE, B.S.C.E., Registered P.E. Twelve years of varied experience in structural design for aircraft bridges and buildings, part government R & D, part with consultant. Also teaching experience. Writes with clarity. Desires permanent position utilizing varied skills. Salary, $10,000 a year. Location, East or West Coast. C-620.

STRUCTURAL ENGINEER, A.M. ASCE, B.S. and M.S. in civil engineering. Experience includes one year structural testing of aircraft and components such as static and fatigue testing with mechanical and electrical strain instrumentation. Salary, $7,000 a year. C-621.

STRUCTURAL ENGINEER, M. ASCE, B.C.E., P.E., 34. Twelve years of broad experience in design, construction, and administration of concrete and steel commercial, industrial, apartment, and institutional buildings with consultants (including chief engineer), contractors, owners. Seeking engineering administrative position with medium-sized engineering or building firm in East. Currently employed Will relocate. C-622.

OFFICE OR FIELD ENGINEER, A.M. ASCE, B.S.C.E. Three years with the Navy civil engineer corps and three and a half years on building construction estimating. Salary, $8,580 a year. C-623.

CIVIL ENGINEER, A.M. ASCE, BSCE, P.E.—State of New York. Seven years of design and field supervision experience in bridge and building department of major railroad; for over five years responsible charge of over 100 employees; and six months of experience with building contractor involving field supervision and estimating. Salary, $9,000 a year. Location, Mid or Upstate New York. C-624.

HIGHWAY OR MATERIALS ENGINEER, M. ASCE, B.S.C.E. and Grad. work, Registered P.E. Eleven years in highway field; past five and a half years in Latin America. Last position as chief engineer for contractor on $40-million highway in West Indies. Strong on soils, pavements. Salary, $8,500 a year. C-625.

CONSTRUCTION MANAGER OR PUBLIC WORKS DIRECTOR, M. ASCE, Graduate C.E., Registered P.E. Twenty-five years of experience in building construction in field and office and in consulting engineering, including general contracting, design, estimates, supervision, surveys, airports, and as manager of Washington and foreign offices. Salary, $10,000-$15,000 a year depending on job and location. C-626.

STAFF ENGINEER, M. ASCE, B.C.E., P.E.—New York. Eleven years of diverse office and field experience designing and constructing in all type structures. Planning, coordination, liaison, project engineering. C-627.

ENGINEERING MANAGER, A.M. ASCE, B.S.C.E., M.S. in Management. Four years of responsible supervision of nuclear power plant construction, test, and operation. Three and a half years supervising inspection and test of Nuclear powered ships; and one and a half years as naval architect. Experience includes planning, coordination, contract administration, and supervision for general construction contractors. Salary, construction contractors. Salary, $10,000 a year. Location, Northeast. C-628.

SANITARY ENGINEER, A.M. ASCE, B.C.E. Six months as part-time laboratory research assistant in sanitary engineering. Salary, $6,600 a year. Location, New Jersey, New York State. C-629.

STRUCTURAL ENGINEER, A.M. ASCE, B.S.C.E., B.S. Business Administration, Registered P.E., 30. Two years with consultant on bridges and buildings; three years with steel fabricator gaining diversified experience and with responsibility for all structural design of company. Will consider foreign assignment. C-630.

STRUCTURAL DESIGN ENGINEER, A.M. ASCE, B.S.C.E., 33. Eight years in structural design of bridges, sanitation, educational, commercial and industrial structures of all types. Salary, $8,000 a year. Location, Midwest or West. C-2003-Chicago.

SANITARY ENGINEER, A.M. ASCE, M.S.C.E., 36. Two and a half years building construction experience; and four years of experience with industrial waste section of a state health department. Now doing specialized work in water supply. Location, West or South. C-2004-Chicago.

PUBLIC WORKS ADMINISTRATOR, M. ASCE, B.S.C.E., Registered P.E., 33. For eight years designed and constructed major municipal works, specializing in water works and sewage treatment; and five years of administrative experience as director of power and water, city engineer and waterworks superintendent and building commissioner. Salary, $10,000 a year, plus. C-2005-Chicago.

CIVIL ENGINEER, A.M. ASCE, B.S.C.E., 35. One year as consulting engineer specializing in subdivisions and sanitation; eight years heavy industrial construction (steel plant); and two years of experience drafting and designing small buildings, railroads, and foundations. Salary, $9,500 a year. Location, Chicago area. C-2007-Chicago.

SANITARY ENGINEER, A.M. ASCE, B.S.C.E., Registered P.E., 31. Five years of experience on the design of sewage treatment plants, sanitary and storm sewers, pumping stations, water distribution systems, subdivisions, reports and specifications for consulting engineer. Salary, $9,500 a year. C-2006-Chicago.

STRUCTURAL DESIGNER, TEACHER, A.M. ASCE, MSCE, 30. Two years as graduate assistant on soil mechanics research; eight months of experience in detailing and designing structural steel structures; and nine months, during three summers, on general engineering work. Salary, $6,600 a year. Location, Coastal Area. Se-145.

SALES ENGINEER, ESTIMATOR, M. ASCE, MSCE. CE License—California, 37. Five years

ENGINEERS

Civil-Structural

Los Angeles

The Bechtel Corporation earnestly seeks high caliber applicants who are desirous of becoming established with a progressive and leading organization with opportunities in design and construction field engineering. Those in the organization participate in an incentive program which affords opportunity, added benefits and security.

Must have experience in heavy industrial projects and have leadership ability. B.S.C.E. degree required.

Relocation allowances cover moving costs plus transportation reimbursement for you and members of your family. Send confidential resume, including present and required starting salary, to Technical Recruiting Division. Personal interviews will be arranged for qualified candidates.

Bechtel Corporation

5120 Soto Street

Vernon, California

ENGINEERS

STRUCTURAL DESIGNERS

Openings in our Cincinnati, Lansing and Louisville offices for graduate engineers for work on bridges and structural projects. Several years' experience desirable but not mandatory.

Overtime allowance, hospitalization, insurance and retirement program for continuing employees.

Submit experience record, references, locality preferred and salary requirements in first letter.

HAZELET & ERDAL

Consulting Engineers

405 Commerce Building

LOUISVILLE, KENTUCKY

of experience in charge of material and cost estimates for construction and budget purposes, design of bridges, dams, water tanks, wharves, prestressing structures, school buildings, military installations. Another five years of experience selling life, health and accident insurance. Salary, $8,400 a year. Location, San Francisco Bay Area. Se-153.

CONSULTANT, M. ASCE, CE, 42. Sixteen years of experience on creative design, sales on commercial and industrial plants for consultants, manufacturers and self-employed. Location, San Francisco East Bay. Se-164.

DESIGNER and SALES ENGINEER, A.M. ASCE, CE, 26. One year of experience with consultant on design, draft on commercial buildings and check shop drawings; one year of experience on quantity estimates, alignment and profile design, some hydraulics for highway construction; and eight months on aircraft stress analysis. Salary, $6,240 a year. Location, San Francisco or Washington, D. C. Se-173.

SENIOR DESIGNER, F. ASCE, D.Sc CE, Hydr, CE License in California, 53. Twenty-nine years of experience in planning, design, layouts, evaluation and construction of hydraulic structures, supervising design, issuing drawings for field construction, submitting design drawings for approval to the chief engineer; and solving difficult problems of a theoretical nature. Salary, $9,600-$12,000 a year. Location, San Francisco Bay Area. Se-235.

CONSTRUCTION SUPERINTENDENT, ESTIMATOR, M. ASCE, CE, CE License in California, 42. Self-employed for eight years on commercial construction, estimating, contracts, ordered materials, supervised construction of buildings; and eight years on the design, estimates, and specifications for plant engineering for an aircraft manufacturer. Salary, $10,000 a year. Location, San Francisco. Se-292.

CONSTRUCTION SUPERVISOR, M. ASCE, CE, 46. Twenty years of varied construction experience, including concrete dams, canals, industrial plants, hospitals, commercial buildings; military facilities construction, such as fuel and communications, docks, housing, power plants, base buildings, facilities and site, ammunition storage, handling and renovation of buildings. Experience includes office and field work, supervisor of engineering office and contact with architects, engineers, clients, manufacturers, subcontractors. Salary, $10,800 a year. Se-1792.

DESIGNER and SALES ENGINEER, A.M. ASCE, CE, EIT, California, 28. Two years of experience on design, layouts, detail structures, mechanical equipment, pipework for municipal sewage treatment facilities, water and sewage systems, and quantity take-off for consultant, and another two years similarly employed. Salary, $6,600 a year. Location, West Coast. Se-1795.

FIELD and OFFICE ENGINEER, A.M. ASCE, MS Soils Foundations, 26. Four years in charge of contract estimates, foundation investigations, reports, and water supply location for contractors, consultants, telephone company over a four-year period. Five months as cost accountant for general contractor. Salary, $7,200 a year. Location, Southern California. Se-1829.

JUNIOR CIVIL ENGINEER, A.M. ASCE, CE, 27. One year of experience surveying, route location, highway engineering for government. Military completed. Commercial pilot's license. Salary, $7,200 a year. Location, Southwest, West. Se-1820.

OFFICE ENGINEER, A.M. ASCE, CE, 32. Two years of experience on form design, cost statements, quantities, production studies, computation for estimating staff for large construction company on construction of missile base, dams, heavy construction. Salary, $7,200 a year. Location, Northern California. Se-1842.

Positions Available

SPECIFICATION WRITER, civil or mechanical graduate, familiar with industrial construction and ability to write specifications for structural and architectural work from design drawings. Also would write piping, heating, equipment instrument specifications from operating and design data furnished by staff engineers. Location, western Pennsylvania. W-9798.

ADMINISTRATIVE ENGINEER, thoroughly familiar with highway engineering and materials to direct divisional activities of engineering trade association. Will require supervision and coordination of operations of several field engineers. Considerable travel on eastern seaboard. Headquarters, Maryland. W-9749.

TRANSITMAN, with building construction experience for concrete work on school job. Salary, $5,200-$6,500 a year. Location, Nassau County, New York. W-9745.

ENGINEERS for commercial, industrial building contractors. (*a*) Office or project engineer with expediting, purchasing and some estimating experience. Design and field experience would be helpful. (*b*) Estimator thoroughly experienced in take-off, pricing and analyzing bids. Location, Connecticut. W-9741.

This is only a sampling of the jobs available through the ESPS. A weekly bulletin of engineering positions open is available at a subscription rate of $4.50 per quarter or $14 per annum, payable in advance.

INSTRUCTORS, graduate degrees required. Opportunities are available in engineering, business administration and economics, the sciences and the humanities. Location, Foreign. F-9733.

ESTIMATOR with engineering training and experience in metal stamping fields to prepare estimates and shop specifications for various sheet and strip metals on short run projects. Salary, $6,500-$7,800 a year. Location, Newark, N. J. area. W-9730.

CONSTRUCTION SUPERINTENDENT, experienced in apartment house construction, for a ten story reinforced steel and concrete apartment building. Salary, $11,700-$13,000 a year. Location, Central New Jersey. W-9723.

CIVIL ENGINEER, recent graduate or with one year's experience, for highway, drainage, construction, i.e., design, layout, drafting. Salary, $5,600-$6,200 a year. Location, Long Island, N. Y. W-9722.

ENGINEERS. (*a*) Structural design engineers (board men), graduate civil engineers preferred with minimum of three years in an engineering office doing principally structural design, preparing structural design drawings and applying structural design principles to specific problems. From $8,400 a year. (*b*) Architectural engineer, with a minimum of five years of experience in writing specifications for complete chemical and industrial plants to include process, manufacturing and lab buildings, utility and administrative buildings and facilities, sewage treatment equipment, etc. Salary, $8,400 a year. (*c*) Field construction engineer, with a minimum of three years on field construction work as a field engineer. Must be capable of handling all problems on a construction contract. Location, western Pennsylvania. W-9720.

PROPOSAL ENGINEER, graduate, experienced in a consulting engineering firm on process plant work where sales promotion, customer proposal experience has been main experience. Salary, $15,000 a year. Location, New York, N. Y. W-9713.

ESTIMATOR with heavy construction experience on dams, earth moving, quarry operation. Location, New York City. W-9699.

ENGINEERS. (*a*) Engineers—hydro design, civil, mechanical, hydraulic and electrical graduates, registered engineers, with four to ten years of experience in the design of hydroelectric projects. (*b*) Project planning engineer, hydrologists. Experience same as above. Excellent company benefits. Location, Midwest. W-9613.

OWNER'S REPRESENTATIVE, with engineering training and preferably under 45, to expedite construction on tract homes, organize subdivision of lots and sales to other contractors, capable of negotiation with contractors for general contractor. Must understand financing (FHA and others). Salary, $8,400 plus expenses; car furnished. Location, San Francisco Bay Area. Sj-5625.

SENIOR ESTIMATOR, CE. Ten to 15 years in building construction; some field experience, but primarily engaged in estimating and completing bids for general contractors on large office buildings or similar structures (not roads, dams, bridges). Salary, $9,600 up, depending on experience. Location, San Francisco. Sj-5647-R.

SANITARY ENGINEER. Eligible for registration in California, around 40. Experience in sanitary engineering, to design and prepare contract plans for sewage disposal and water treatment plants and appurtenant works for consulting civil engineer. Opportunity to become associate of firm or part-owner. Salary, about $9,600 a year. Location, Northern California. Sj-5643.

SENIOR DESIGNER, C.E. Well qualified to design dams, water storage distribution and control and appurtenances such as spillways, etc., for engineering consulting firm. Will work directly under chief engineer and should be capable of handling all aspects of such tasks. Salary, $9,000-$10,000 a year. Location, San Francisco. Sj-5651.

OFFICE ENGINEER, U. S. Citizen, CE or Structl, with mechanical and electrical aptitude; or ME or EE with interest in construction. Some experience, young. For medium and heavy building (industrial, utility, military), process piping, electrical, mechanical. Also client contact and negotiations, material listing, etc. Starting salary, $140 per week. Location, Utah. Sj-5676.

GEOLOGIST, Registered CE with knowledge of concrete, soil mechanics, geophysics & groundwater hydrology and ability to manage lab operations. Location, Southwest California. Sj-5642-R.

DESIGNER, LAYOUT, CE, California Registration, to 45. Three to five years of recent experience working on sewer projects. May do some layout and field survey work and in addition to engineering work will have charge of maintenance and construction crews for a sanitation district. Salary, $644 plus a month. Location, North Bay Area. Sj-5699-R.

DESIGNER, at least three years experience in fields closely related to sanitary engineering, preferably with some experience in consulting engineer's office. Position would develop into key man in organization. Salary, $7,200-$10,800 a year depending on experience. Location, Sacramento. Sj-5692-R.

FIELD ENGINEER, CE, under 45. Minimum three years of experience in field supervision, field office work, including design and application; plus some preference for well developed structural experience. Must be able to handle both field and engineering department work. For small group in large transportation company. Salary, $7,200-$7,500 a year. Location, San Francisco. Sj-5689-R.

ENGINEER, CORRESPONDENT, CE, Structl or Archtl graduate, under 35, with good command of written English and able to understand and interpret technical information and make clear engineering calculations and sketches. Sound engineering background essential, preferably design or other experience in light construction. In response to technical inquiries will advise and assist specifiers, builders and industrial users on matters pertaining to proper use of plywood; assist architects and engineers in plywood structural design; and prepare sample design, both for unusual and conventional uses. Some writing and editing of technical bulletins. Salary, $6,500-$8,500 a year depending on experience. Location, Pacific Northwest. Sj-5679-R.

FIELD ENGINEER, CE. Prefer graduate with some experience who is able to do field and office operations and occasionally some laboratory work on foundations, investigations, observing and supervising test drillings, control of compactions and grading, observing and reporting foundations and pile driving for small and growing consultant. Salary, about $7,200 a year. Location, Marin County. Sj-5678-R.

SANITARY ENGINEER, Graduate, Licensed, 35-50. Ten to twenty years of recent consulting practice experience in large water and sewage project work. Demonstrated capability of managing water and sewage design staff for long established utility engineering consultant. Salary, $10,000-$12,000 a year plus. Location, Western U.S. Sj-5663.

STRUCTURAL DESIGNER, CE, Registered, 35-50. Ten to fifteen years of consulting practice experience in dams (must have had substantial recent experience on arch dams) for long established engineering consultant. Should have demonstrated capability to lead design group. Salary, about $10,000 a year plus. Location, Western U.S. Sj-5662.

JUNIOR OFFICE ENGINEERS, Graduate CE or MinE, 25-30. Up to five years of experience in general engineering duties. Will maintain quantity and cost records, perform take-offs, for contractor under office engineer. Salary, $115-$135 a week depending on experience. Location, Utah. Sj-5675.

CHIEF ESTIMATOR, CE background. Should have had recent top level experience as chief estimator including everything from take-off to final estimate and continuing adjustments, also should be able to deal with client in preliminary discussions regarding costs and estimates extracted from preliminary information, flow sheets and including negotiating capability. Will be concerned with heavy concrete large development, warehousing, tilt-ups, complete plants, principally manufacturing for general contractor who does a great deal of work with his own equipment. Salary, $12,000-$15,000 a year. Location, San Francisco East Bay. Sj-5656.

ASSISTANT CITY ENGINEER, CE, eligible for registration. Experienced in civil engineering design, office and field procedures preferably with municipal government or equivalent. Under city engineer will perform field and office engineering work, location, design, construction and reconstruction of storm drains, water systems, sewers and streets, survey city streets, parks, review improvement plans and final maps of subdivision. Salary, $8,700 a year, depending on experience. Location, Alaska. Sj-5654.

EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

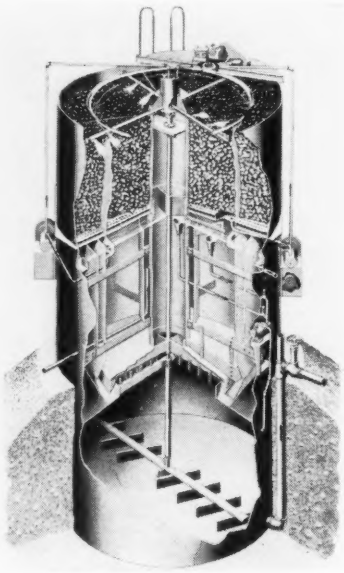
Sewage Treatment Unit

THE BIO-PAC, A COMPLETE two-stage bio-filtration system in a single compact unit, now provides an economical, easy to operate, modern sewage treatment plant for small capacity needs. With a 2:1 recirculation (1:1 in each stage) the unit was designed in accordance with criteria established by the "Ten States Standards for Sewage Works." Designed for domestic sewage only, Bio-Pac should not be used for industrial wastes.

Assembled in a cylindrical steel housing the Bio-Pac varies in size from 8 ft in dia and 22 ft high to 18 ft in dia and 30½ ft high. About ⅔ of the unit can be buried and the rest adapts easily to the surrounding landscape.

Within the single housing are included: a primary settling compartment with mechanical sludge collector, primary high-rate filter with motor operated rotary distributor, secondary settling compartment with mechanical sludge collector, secondary high-rate filter with motor operated rotary distributor, separate sludge digestion compartment with mechanical scum breaker and a mechanical sludge mixer-collector, primary and recirculation pumps, scum pump and four ½ hp secondary motors.

Manufactured in eight sizes for population equivalents varying from 50 to 500 people, Bio-Pac was designed based on a 24-hour average flow of 100 gal per capita and a daily B.O.D. loading of 0.17 lb per capita. Power requirements for the unit range from 1.5 to 2 kw. Units for up to 200 people are completely factory assembled and shipped ready to be set in place. Larger units are factory assembled in convenient sections for easy field assembly. The Bio-Pac is identical in principal to the bio-filtration system used in many of the nation's largest cities. It removes 85 to 95 percent of the organic material and produces a stable effluent satisfactory for discharge into streams. **Link-Belt Co., CE-12, Prudential Plaza, Chicago 1, Ill.**



Small Scale Sewage Treatment Unit

Nail Driver

THE DEVELOPMENT of the CP-5XBND Nail Driver, an air-operated tool capable of driving any nail from 20 penny to 60 penny sizes has been announced. Acclaimed by workmen, management and safety engineers, the nail driver is a well balanced tool ideal for anyone engaging in nail driving. Only 14 in. long, the lightweight driver can reach into tight corners, eliminating the hazards encountered in sledge hammer operations. Nails are safely enclosed in a sleeve while being driven. Safe, easy and fast, the driver can be operated from a small industrial-type air compressor. **Chicago Pneumatic Tool Co., CE-12, 6 East 44th Street, New York 17, N.Y.**

Arc Drawing Ruler

THROUGH THE DEVELOPMENT of the new Acu-Arc Ruler, a device has been designed to provide the draftsman with a rapid and accurate means of drawing arcs of circles of large radii. The ruler can be used to draw arcs of circles of any radius from 7 in. to 200 in. or more with ease even if the center point of the circle is beyond the edge of the drawing surface. This new tool eliminates the need for highway curves, railroad curves, splines and weights and other tedious tools in drawing arcs.

A movable pointer on a scale reading radius length directly gives the exact arc required. A chart is provided to convert the radius readings to civil engineers scales. Center lines, center points and radii for arcs already drawn can be quickly and easily determined by the use of Acu-Arc. **Hoyle Engineering Co., CE-12, 25408 W. Hwy. 66, Barstow, Calif.**

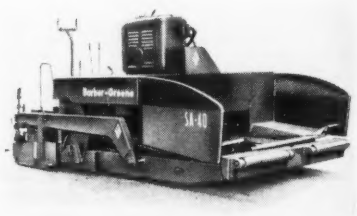
Anti-Corrosion Coating

RESULTS OF A 3-year test on steel fasteners in a highly corrosive industrial atmosphere show the marked superiority of Bethalume coating over other coatings. The Bethalume coating, obtained by immersing an iron or steel product in a molten bath of pure aluminum, protects the fasteners completely. A recent check of test racks which had exposed coated products for 3 to 5 years at locations in Hawaii and on the West Coast revealed that the coating is ideally suited for application in marine atmospheres.

The coated fasteners also have a remarkable resistance to heat corrosion at elevated temperatures. Tests at 1600 deg F for as long as 1000 hours have shown absolutely no scaling of the protected steel. Bethalume is especially recommended for aluminum fabrication. It is non-galling and can be applied to all types of steel fasteners. **Bethlehem Steel Co., CE-12, Bethlehem, Pa.**

Asphalt Finisher

DESIGNED TO LAY ANY sort of asphalt surface, in widths from 8 to 14 ft, the Model SA-40 Asphalt Finisher is capable of laying speeds in the 100 ft per min range and also possesses unusually high travel speed for a crawler mounted paver. Hydraulically raised hopper sides provide a self-cleaning receiving hopper. An oscillating pivoted truck contact roller permits the paver to push a mis-aligned truck without affecting the operator's directional control of the finisher. Hopper gates are crank controlled from the screed platform for ease in adjustment. 7 ft crawlers, with optional 10 in. or 12 in. crawler pads, are individually controlled and mounted on a 3-point oscillating suspension. Compaction before strikeoff is provided by a hydraulically driven tamper and an extra-heavy duty heated screed, all mounted on automatically leveling support arms.



Model SA-40

Dual control columns, one on each side of the operator's platform, provide fingertip steering ease. Each column also has individual electric switch controls for manual operation of the feeders, for raising the self-cleaning hopper sides and for start-stop control of the tamper. **Barber-Greene Co., CE-12, 400 No. Highland Ave., Aurora, Ill.**

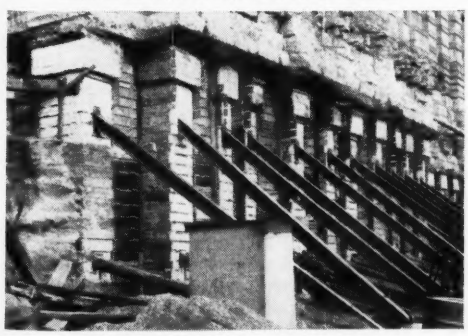
ANOTHER PROBLEM SOLVED BY SPENCER, WHITE & PRENTIS

Project: Indianapolis City-County Building
Owner: Indianapolis-Marion Building Authority
Architect: Allied Architects & Engineers, Inc., Indianapolis
General Contractor: Huber, Hunt & Nichols, Inc., Indianapolis

SAFE TEMPORARY UNDERPINNING NEEDED:

Here's how alternate pit plan solves problem economically

Excavation requires 50,000 sq. ft. of sheeting



10"—42# steel beams brace underpinning

Indianapolis desired to occupy the above-pictured City-County offices while erecting Section I of a new home on the adjacent lot. The existing structure would then be demolished and replaced by Section II of the new building.

Prior to its demolition, some means of temporarily supporting the massive old edifice was required. After study of soil conditions, Spencer, White & Prentis devised a system of intermittent underpinning pits which solved the problem without need of a continuous underpinning wall (as had originally been contemplated).

The pit system, going 20 ft. to subgrade, provided a safe and dependable – as well as an economical – method of carrying the heavy load. The award to Spencer, White & Prentis also included 50,000 sq. ft. of horizontal wood sheeting used for bank support. Catalog on request.

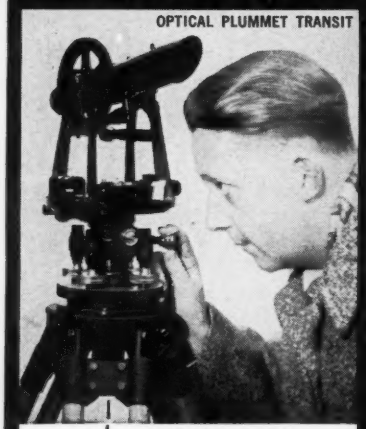
Spencer, White & Prentis INC.

10 E. 40th St., New York 16, N. Y.

Detroit: 2033 Park Ave. • Chicago: 221 North LaSalle St. • Washington, D. C.: Tower Bldg.

Foundations Piling Underpinning Shoring Cofferdams Special Services

Fennel
CHOOSE FROM OUR COMPLETE LINE
OF TRANSITS, LEVELS & ENGINEERING SUPPLIES



Check your needs:
☐ 6½" Transits
☐ 5¼" Transits
☐ Theodolites
☐ 18" Levels
☐ Tilting Levels
☐ Rods, Tapes
☐ Plumb Bobs
☐ Planimeters
☐ Builder's Instruments

Send for latest catalog showing newest instruments, and for name of nearest Fennel dealer

FENNEL INSTRUMENT CORP. of AMERICA
50 Colfax Avenue, Clifton, N. J.

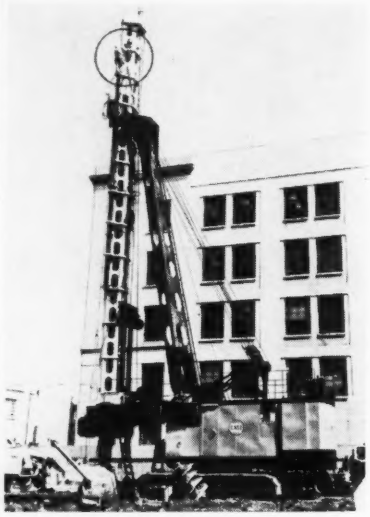
EQUIPMENT, MATERIALS and METHODS

(continued)

Giant Mechanism

A NEW CONSTRUCTION DRILL, a towering giant reaching a height of nearly eight stories, will enable crews to drill through practically any type of soil, anywhere in the world, down to solid rock at depths as low as 200 ft, and to install concrete caisson foundations as large as 15 ft in dia to support structures of any size or load.

Caissons formerly were limited to the depth they could be put down by the capacities of the machine drilling equipment. The new drill is expected to overcome every known natural or man-made obstacle in the ground, including previously unpenetrable rock boulders, old cement foundations and other types of obstructions.



World's Largest Construction Drill

The drill is powered by a 375 hp supercharged diesel engine with an Electro-Motive torque converter. Hydraulic rams and air-activated clutches give the operator finger control in operating the giant mechanism. The equipment will be used in installing foundations on large land projects, such as skyscrapers and industrial plants, and for marine construction in Lake Michigan, bridge supports in the middle of the Mississippi River, and offshore installations on the West Coast and in the Gulf of Mexico for the oil industry. **Case Foundation Co., CE-12, P.O. Box 298, Roselle, Ill.**

Remote Batching Console

A UNIQUE REMOTE CONSOLE for batching concrete in the dispatcher's office 160 ft from the batch deck increases labor productivity, insures accuracy in filling orders and reduces equipment maintenance costs at Superior Sand & Gravel Co., Glendale, Ariz. 10 different pre-set formulas of 7 different materials are remotely batched by this compact unit. The operator is handed a batch ticket by the dispatcher with complete written instructions as to formula, batch size and other specifications. This avoids errors of misinterpretation possible when instructions are given over an intercom system to a noisy batch deck. Each ticket is numbered on a stamping machine to coincide with a like number appearing on the record of the batch from the recording machine. This provides a permanent cross reference for future check or verification of the customer's order. During periods when the plant is short handed, one man can serve as dispatcher, batching plant and aggregates system operator from a single station. With the batching console in the dispatcher's office, electrical parts are removed from the usual dust and dirt of the batch deck and equipment maintenance is reduced substantially. **Noble Co., CE-12, 1860 7th Street, Oakland, Calif.**

Ice Melting Mixture

THIS WINTER MOTORISTS will benefit from but may wonder how engineers are clearing roads of ice so fast after storms. The secret: a new procedure for melting ice quickly that has caught on in the highway industry. The new idea is a mixture of two chemicals, rock salt and calcium chloride. Each has been applied separately in past years to melt ice, but mixing the two produces a potent formula which turns hard packed ice into slush in a matter of minutes, even at low temperatures. Slush is cleared off routes and pavement is dry and safe for travel. The mixture has been thoroughly tested on three major toll roads and in a host of state highway departments. Every test has proved the mixture melts ice faster and at lower cost. **Calcium Chloride Institute, CE-12, 909 Ring Building, Washington 6, D.C.**

Caulking Compound

DESIGNATED AMIANCO, a unique caulking compound is now replacing lead for caulking all kinds of pipes, shafts and tunnels, steel pilings, and for pressure grouting. It is based on an asbestos fibre which is impregnated with a rapid hardening cement, certain chemicals and contains a trace of bitumen. A British product, the compound has stood the test of over 10 years use and is now demanded for use in all major projects where caulking is required. It gives a surprisingly

(Continued on page 121)

EQUIPMENT MATERIALS and METHODS

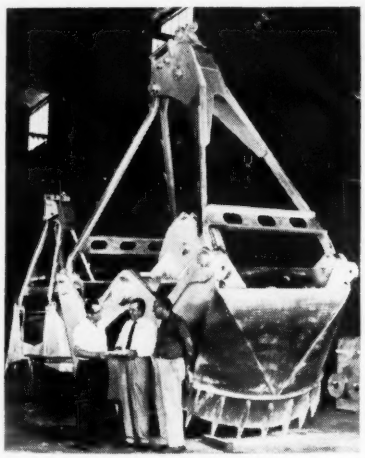
(continued)

flexible and resilient joint, thus making it ideally suited to withstand traffic vibrations and expansions and contractions of linings. It is highly recommended for use under wet or damp conditions.

Caulked with this compound, a joint will immediately withstand working pressures up to 50 psi, and up to 300 psi after 36 hours. After this period, the joint will tolerate pressures of over 1,000 psi. Amianco can be jointed without heat, simply by tamping the material into place with a wet caulking tool. **Magnalum Products, Inc., CE-12, 80 W. 21st Street, Hialeah, Fla.**

Clam-Shell Bucket

THE LARGEST CLAM-SHELL bucket ever produced in the South, has been fabricated for Mall, Inc., an offshore marine construction company, which presently operates three dredges in southern and southwestern Louisiana. The "Big Bucket," weighing some 24,000 lb, is a 15 yd, round-nose type which can handle 18 yd of material. It will be used as part of a huge 183 M Marion drag-line and clam-shell system on a new barge, soon to be placed into service by the Mall Company. **Yaun Manufacturing Co., Inc., CE-12, Baton Rouge, La.**

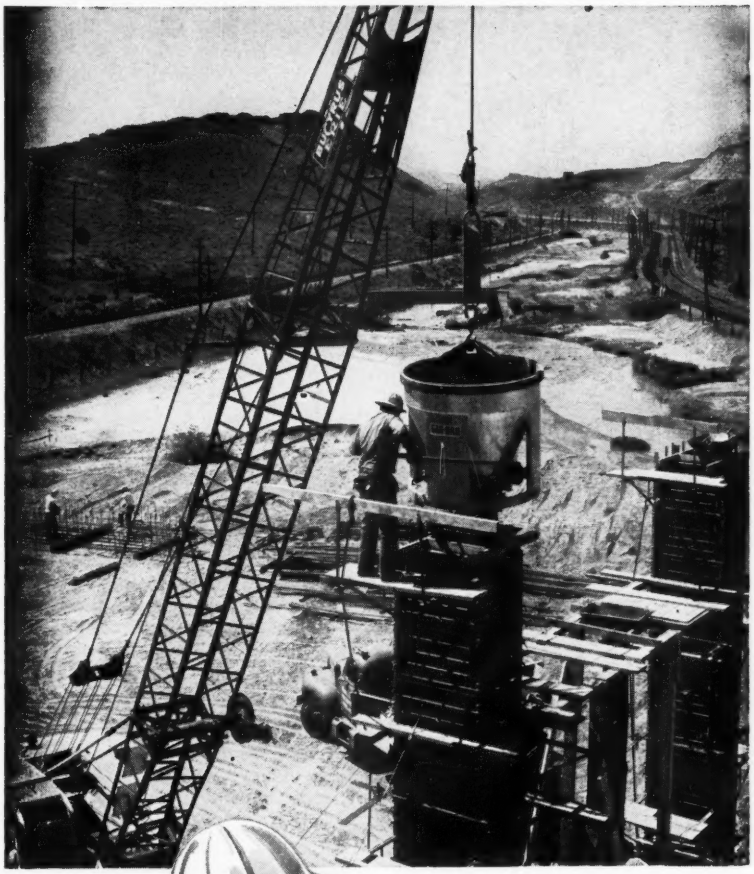


"Big Bucket"

New Transparentized Intermediate

A NEW BLACK LINE INTERMEDIATE PAPER (102-ITF) offering fast speed and reprint density for increased print produc-

(Continued on page 124)



Here's an Idea!

GAR-BRO helped cut costs in pouring concrete piers!

One contractor cut the time in placing concrete on this bridge job by planning ahead. Here, on these two bridge piers, note that he used three complete units comprised of Gar-Bro Collection Hopper and a string of Steel Chutes plus a Gar-Bro Bucket. He used the hopper and chutes to direct the concrete into the forms and prevent segregation.

His object was to prevent any delays by using one hopper and chute unit to place concrete in one pier, while the second one was set in place in the other pier, and the third one (see it hanging in rack between piers) was being shortened. Delays of transit mixers and the crane were minimized by rotating the hopper and chute units and shortening the chute line to the new level of the concrete in each pier.

It's a good idea to team up your Gar-Bro Concrete Handling Equipment to save time and cut costs.

See your Gar-Bro dealer or write for Catalog and Concrete Handling Manual today!

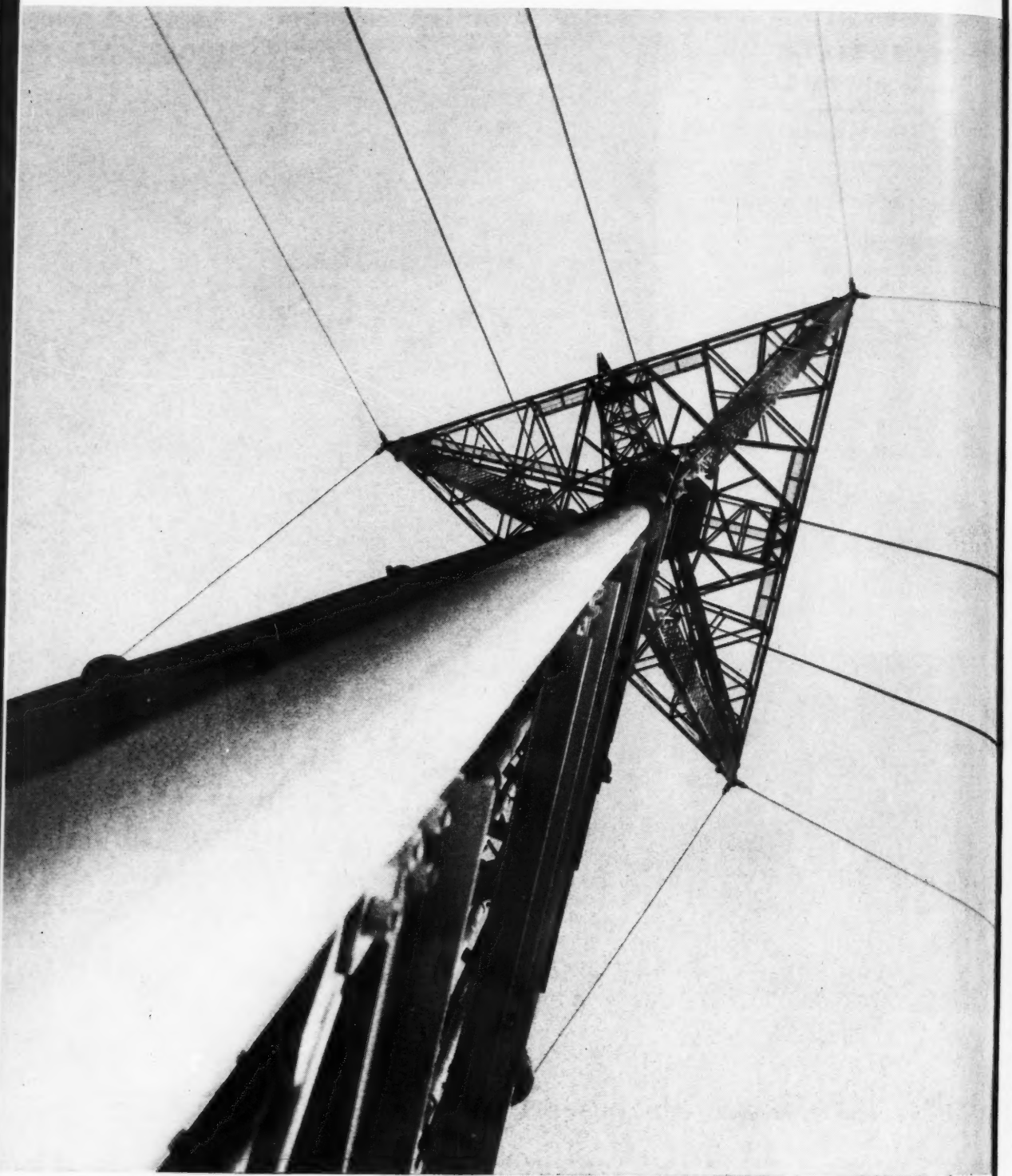
Gar-Bro Mfg. Co. — Los Angeles, Calif.—Peoria, Ill.

General Offices: 2415 E. Washington Blvd., Los Angeles 21, Calif.

GAR-BRO

The World's Most Complete Line of

CONCRETE HANDLING EQUIPMENT



World's first 3-antenna, candelabra-type TV tower built for Baltimore stations WBAL, WJZ and WMAR. Tower Design and Fabrication: Dresser-Ideco Company, Columbus, Ohio. Tower Erector: J. F. Beasley Construction Company, Muskogee, Oklahoma.

Candelabra-type TV tower built with USS "T-1" Steel legs to withstand hurricanes

This spectacular three-channel television tower makes it easy for fans in Baltimore, Maryland, to tune in different stations—they are all in one spot. Built to withstand hurricane winds of 165 mph, the tower makes key use of *super strong* USS "T-1" Steel in the three 625-foot legs. The total tower height is 730 feet.

Three 10-ton antennas are perched on top of a triangular platform, 105 feet on each side. According to Dresser-Ideco Company, designer and fabricator of the tower, USS "T-1" Constructional Alloy Steel was selected for the tower's main support members because of the weight problems imposed by the heavy top. Had structural carbon steel been used, the legs would have been almost twice as thick, adding further wind resistance and stress.

Weight saved. Instead of about 300 tons, for carbon steel, only 105 tons of "T-1" Steel were needed for the legs. They are solid rounds, quenched, tempered, straightened, and stress relieved in diameters of 7 inches for the first 480 feet and 5¾ inches for the remaining 145 feet. Use of "T-1" Steel saved freight, fabrication costs and foundation costs.

Super strong legs of USS "T-1" Steel support the tremendous weight of the tower. Their smaller size reduces wind resistance.

"T-1" Steel for extra high strength. The minimum yield strength for USS "T-1" Steel is 100,000 psi in rounds up to 4 inches in diameter. This is three times the yield point of structural carbon steel. For tall towers, the advantages of reducing leg size and weight are obvious.

Increase in paint life. "T-1" Steel has four times the resistance to atmospheric corrosion of carbon steel. This results in a considerable increase in paint life.

In addition to USS "T-1" Steel, United States Steel makes three High Strength Steels, USS MAN-TEN, USS COR-TEN and USS TRI-TEN Brands with a 50,000 psi minimum yield point. For more information, write to United States Steel, 525 William Penn Place, Pittsburgh 30, Pennsylvania.

USS, "T-1", MAN-TEN, COR-TEN and TRI-TEN are registered trademarks

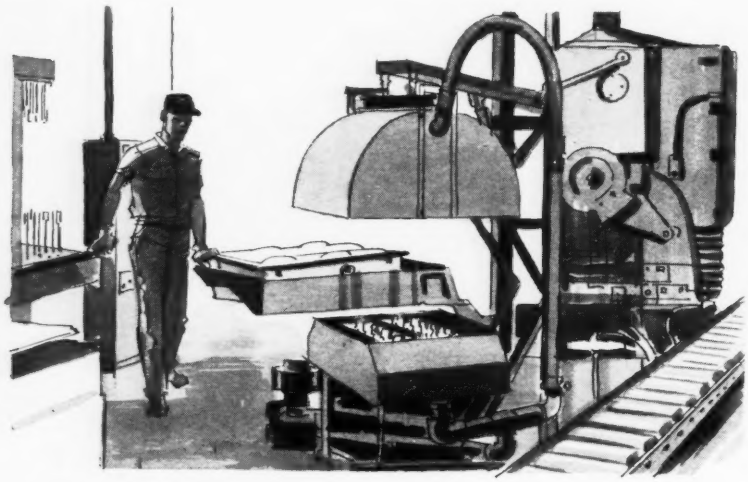
This mark tells you a product is made of modern, dependable Steel.

United States Steel Corporation—Pittsburgh
Columbia-Geneva Steel—San Francisco
National Tube—Pittsburgh
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Supply—Steel Service Centers
United States Steel Export Company

United States Steel

Watch United States Steel's special Christmas show, **The Coming of Christ**, in Color on NBC-TV, Wednesday, December 21, 8:30 P.M., E.S.T.

tion, has been developed for architectural, engineering and military drawings, office copying and accounting work sheets. Advantages of the new transparentized intermediate include: extremely high opacity for greater covering power with no sacrifice in printing speed. This results in greater ability to pick up fine detail from weak pencil line tracings. The black image color provides easy readability for drawing or shop use, and is excellent for duplicating by photographic or Xerographic reproduction processes. The 100% rag content high quality tracing vellum base offers a good drawing surface for pencil or ink and gives high durability and resistance to wear. The paper is permanently transparentized to insure high reprint speed with continued use or aging, and the transparentizer will not transfer to other papers in file. The material can be interfiled with silver materials, and it will not adversely affect Van Dyke or photographic materials in file. The new diazo intermediate is single coated and highly resistant to yellowing. It can be processed in any dry diazo whiteprinter. **Ozalid Division of General Aniline and Film Corp., CE-12, 62 Corliss Lane, Johnson City, N.Y.**



The M & H Spirit

There are those who might believe that a valve is just a valve. They might say: "What's in a name? All valves are made of about the same iron and bronze – so what?"

The answer is that one valve can be better than another because it is more skillfully designed and the men who make it are craftsmen who take greater pride in their work. The honor and honesty of a man – his veracity, fidelity and sincerity – is best shown by his acts.

It is by their daily work at M & H that the attitude of M & H personnel toward M & H products takes on form and substance. We call it the M & H Spirit – and it is an inherent factor in the quality and operating efficiency of an M & H Valve or Hydrant.

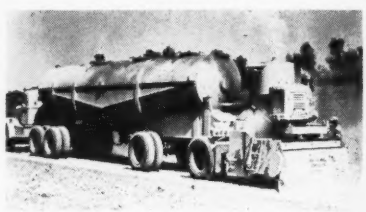
Thirty-four years of M & H history proves that an M & H Valve or Hydrant is in a class by itself. Its record of efficient trouble-free service has caused the Company to grow from 60 to 500 employees, with a present annual payroll of over $2,000,000.00. It has so rapidly increased in use throughout the U. S. and foreign lands that M & H Company has become one of the leading industries in its field.

(No. 7 of a Series)

M&H VALVE
AND FITTINGS COMPANY
ANNISTON, ALABAMA
SUBSIDIARY OF WALWORTH

Delta-Matic Unit

A CYCLONE UNIT which speeds the laying of base courses for new highways and reduces contractors' costs, has been developed for use in conjunction with dry cargo highway transports which carry bulk loads of dry cement and other pulverized materials.



New Cyclone Device

The new unit drains the dry cement from the transports' high-speed discharge air streams. This practice involves spreading dry cement on the ground, mixing into the soil and adding water (if needed) right on the planned course of new highways, runways and other facilities. This produces a stabilized bed which is later surfaced with bituminous or concrete topping, depending upon the new pavement's planned use and anticipated traffic volume.

The new system eliminates the need for special equipment such as cement storage bins and dump trucks as well as substantial numbers of workers including truck drivers, laborers and bin operators. A Continental engine-driven blower is mounted on a Flynn cement spreader behind the cyclone device, and furnishes air to operate the unit. **Delta Tank Mfg. Co., Inc., Materials Handling Equipment Division, CE-12, P.O. Box 1469, Baton Rouge, La.**

"Scaffold-Truss" Shoring System

OVERALL SAVINGS OF up to 20% in lumber, labor and equipment are reported possible with the new "Scaffold-Truss" for shoring interior and spandrel beams and open slabs. This system incorporates a weight-bearing truss which permits using fewer frames because of more efficient distribution of shoring weight. Truss

(Continued on page 126)

Architect's sketch of new post office, Providence, Rhode Island. Architect-Engineer: Charles A. Maguire & Associates, Providence, Rhode Island.

First mechanized post office . . .

concrete domed shells provide 420′ x 300′ area with just two interior column groupings

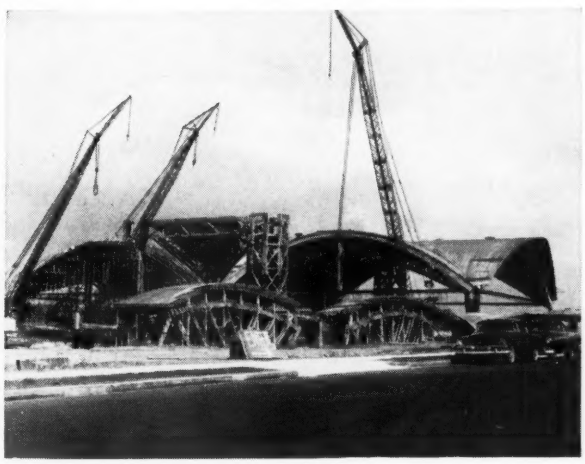
A mechanized post office at Providence, R. I., is first step in a postal modernization program that will eventually provide "next-day" delivery anywhere in the U.S.

Six intersecting concrete shells form the multiple domed roof. Two four-column groups provide the only interior support. This permits unobstructed floor space essential to the electronically controlled mail-flow layout and allows the flexibility required for experimental spotting and rearrangement of machines. Another benefit of a shell roof was to eliminate exterior buttresses of conventional arch construction which would interfere with outside truck traffic.

A concrete weighing 110 lb. per cu. ft. with a 2-inch slump and seven-day strength of 4,000 psi was used. Aggregate consisted of sand in combination with expanded shale. An air-entraining agent was added.

For design data on barrel shells and on standard, skewed, groined and sloping hyperbolic paraboloids, write for free literature. (U.S. and Canada only.)

PORTLAND CEMENT ASSOCIATION
Dept. 12-13, 33 W. Grand Avenue, Chicago 10, Ill.
A national organization to improve and extend the uses of concrete



Falsework consisted of two identical sets of timber truss framing. 6′-thick shells each required 800 cu. yds. of concrete, placed in two operations. Spanning 150 x 140 ft., shells are separated by 2-in. expansion joints.

FOR STRUCTURES... MODERN **concrete**

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YOUR ENTIRE JOB IS PRE-ASSEMBLED AT OUR PLANT TO ASSURE ACCURACY, PRIOR TO SHIPMENT
AN ERECTION DIAGRAM IS SUPPLIED FOR YOUR FINISHED JOB.

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PLAZA 6-4850

BLAW-KNOX Grating Representatives Are Located In Principal Western Cities.

EQUIPMENT MATERIALS and METHODS

(continued)

design allows for precise placement of standard jack screws under ledgers to substantially reduce cutting, wedging and fitting of stub lumber, spandrel beam T-heads and short soffit headers. The jack screw can be used from job to job. **Automatic Devices, Inc., CE-12, 2400 Adie Road, Maryland Heights, Mo.**

Increased Durability

THE EXTRA HEAVY-DUTY T-850 features separate mounting of front-end sheet metal and fenders, cab and radiator to relieve metal strain from frame twist and vibration, and to increase durability. Radiator shutters form the grille, thus eliminating 'expensive to repair' decorative grille work. The cab is shortened by nearly 10 in. Longer lasting springs, tougher frames and longer wheelbases, as well as improved noise control and ventilation, provide greater comfort.

Improved T-850

Improvements made to the engine include oil bath air cleaners, fans, more durable radiators, new connecting rods and a 180-deg thermostat. Electrical system components include single 7-in. headlights for reduced replacement cost, a moisture-proof wiring harness, cab-mounted fuse boxes, theft-resistant ignition and dual electric windshield wipers on most models. A high output heater-defroster is also available. Maximum gross vehicle weight of the T-850 is 45,000 lb. In addition to the normal warranty, there is an exclusive 100,000 mile warranty on Super Duty V-8 engines, including full labor costs up to 50,000 miles. **Truck News Bureau, Ford Division of Ford Motor Co., CE-12, Rotunda Drive at Southfield Road, P.O. Box 608, Dearborn, Mich.**

Curbing Mixes

RUN-OF-PLANT asphalt paving mixes may conveniently be modified to meet asphalt curb mix requirements by the addition of powdered asphalt to the heated

(Continued on page 130)

43 PRESTRESSED CONCRETE I-BEAMS for unique Budd Car Building

As each of the 20-ton prestressed beams was needed, it was moved to the site and erected by crane. Beams are 44″ deep and span 46′ 10″ between column centers.

. . . made with Lehigh Early Strength Cement

Now complete at Somerville, Mass., is the Boston and Maine Railroad's new Budd Car Servicing Building—built of concrete for fire safety, efficient operation, long life and low maintenance.

All 43 of the big I-beams used on the job were identical in size and shape, which contributed to the simplicity and economy of their manufacture. Forty-one of the beams were designed for a total uniform load of 1,680 psf, plus four concentrated monorail loads of 1,500 pounds each. The other two beams required additional prestressing strands to handle loads from a sand storage tower.

Lehigh Early Strength Cement was used by New England Concrete Pipe Corporation, manufacturer of the beams, to maintain a fast, economical casting cycle paralleling progress on the roof structure. The strength specified for application of prestress—4,000 psi—was reached in just 15 hours, one third the time required with normal portland cement.

This is another example of the advantages of Lehigh Early Strength Cement in modern concrete construction. Lehigh Portland Cement Company, Allentown, Pa.

LEHIGH CEMENTS

Budd Car Servicing Building
Somerville, Mass.

Owner:
Boston and Maine RR.

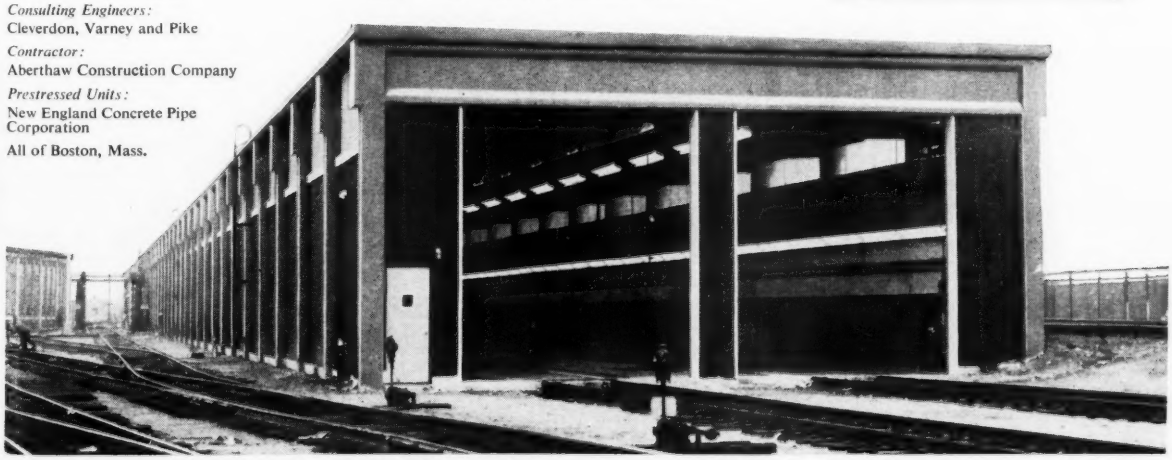
Architect:
Bastille Halsey Associates

Consulting Engineers:
Cleverdon, Varney and Pike

Contractor:
Aberthaw Construction Company

Prestressed Units:
New England Concrete Pipe Corporation

All of Boston, Mass.



Nearly 33,000 square feet of floor area are provided by the unique 720′ long one-story service building. It has 40 bays and a floor-to-roof clearance of 17′.

132 Different Diameter-

the right one can save you

r- Thickness Combinations...

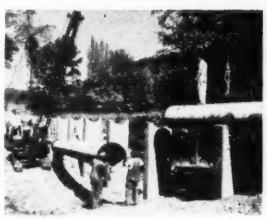
ou money when you need water pipe

Between the range of diameters from 6″ to 36″, Armco Welded Steel Pipe is available in 132 different diameter-wall thickness combinations. This unparalleled range of sizes means you can specify the pipe that meets your requirements EXACTLY. No need to settle for the "next heaviest wall" and all the extra cost of extra material.

Is the extra weight a significant amount? Consider this example: In one mile of 14″ OD pipe, the weight difference between .172″ wall thickness and .188″ wall thickness is *six tons!* In larger pipe, the weight difference is even greater.

Arrange now to discuss your Welded Pipe requirements with your nearby Armco man. Armco Pipe is made to meet the applicable Standards of AWWA and Underwriters' Laboratories, Inc., and ASTM Specifications. Use the coupon to tell us your needs. No obligation! Armco Drainage & Metal Products, Inc., 5000 Curtis Street, Middletown, Ohio.

New steels are born at Armco



ARMCO DRAINAGE & METAL PRODUCTS, INC.
Department G
5000 Curtis Street, Middletown, Ohio

Please have the Armco sales engineer in my area make an appointment to discuss Armco Welded Steel Pipe for the following applications:_____

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ORGANIZATION _____

STREET _____

CITY _____ ZONE _____ STATE _____

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Subsidiary of ARMCO STEEL CORPORATION

OTHER SUBSIDIARIES AND DIVISIONS: Armco Division • Sheffield Division • The National Supply Company • The Armco International Corporation • Union Wire Rope Corporation

A Guide to OP and VP

Gurley Optical Plummet

The Optical Plummet Transit opens new avenues in accuracy, speed and convenience...eliminates inconvenience and lost time involved in centering a plummet over a point.

The Optical Plummet is a telescope through the vertical center (spindle) of a transit. It will point vertically when the transit plate is level. The telescope is turned at right angles by a prism, so that vision is actually horizontal. Setting and adjustment may be checked very simply and precisely by rotating the instrument 180 degrees.

The Gurley Shifting Head Tripod permits 1¾" movement of the transit in two directions 90° separated, without material disturbance to the level of the plate (the Optical Plummet thus remains operative through the entire centering procedure).

Advantages of the Gurley Optical Plummet Transit

- Saving in set-up time, as much as 33%—a factor when a crew is waiting.
- Eliminates swaying plumb bob.
- More accurate centering over point.
- On construction work—sights on points some distance below, such as encountered in bridge work and building construction.
- Made in U.S.A.—Little servicing, but easily repaired when necessary.

Gurley Optical Plummet Transits Available in 21 Combinations

With Circular Compass	With Trough Compass	Without Compass
OP-52	—	OP-57
OP-62	—	OP-67
OP-132	OP TC 137	OP-137

And with limb reading to 1 min.; 30 sec., Stiff-leg or Extension-leg Tripods with Constant-Level Shifting Head and wide-frame European construction.

Variable Power is standard on Gurley Transits and Levels:

- Wide range of magnification with **one** eyepiece—zooms for near or distant objects
- Easily adjusts to suit weather and light conditions
- Built-in haze filter

At high power:
- longer shots
- less glare in bright sunlight
- increase in readability
- no glare...high contrast
- blacks and whites stand out

At low power:
- greater field
- brighter field
- decrease of heat waves

We will be pleased to send you further information about both Gurley Optical Plummet Transits and Gurley Variable Power Eyepiece.

Both Optical Plummet and Variable Power are patented.

W. & L. E. Gurley • 518 Fulton St., Troy, N. Y.

EQUIPMENT MATERIALS and METHODS

(continued)

aggregate before blending with asphalt cement. Recently completed tests indicate that the addition of about 15% of powdered asphalt to a dense-graded paving mix (based on the weight of asphalt in the mixture) will produce a suitable mix for curbing, and produce an appropriate increase in binder quantity. This percentage estimate is based on the use of 85-100 penetration grade asphalt. When an asphalt cement of higher penetration grade is used, more powdered asphalt may be required for best results.

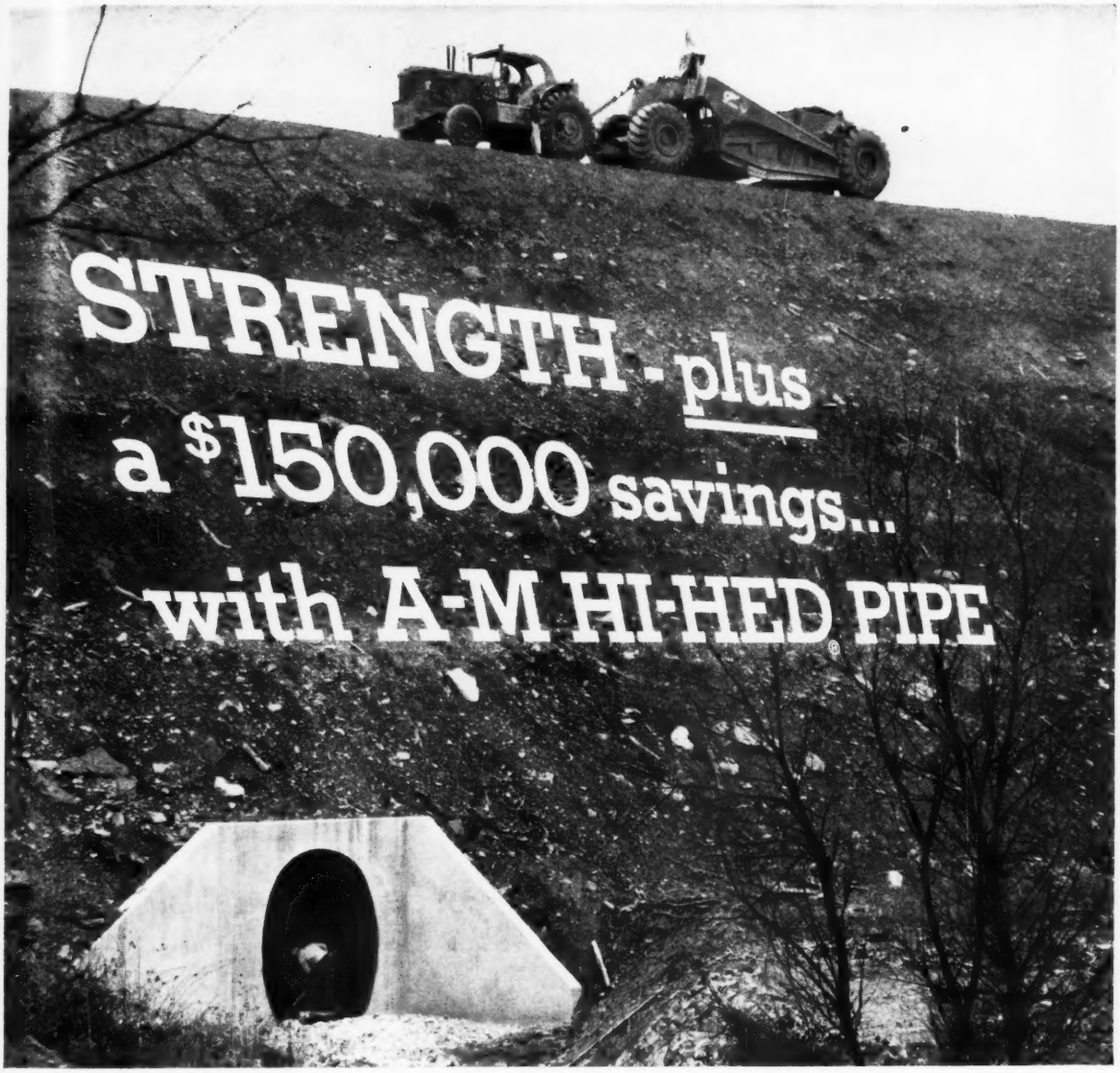
Tests have also been conducted on mixes using asbestos fiber and other mineral fillers for very high stability asphalt pavements. Mixes using asbestos fibers will be used in experimental bus stop paving zones in Cleveland. Mix specimens, with and without 2.5% of short asbestos fibers, were prepared and subjected to laboratory evaluation. The standard paving mixes produced unsatisfactory stability values but, when asbestos fibers were added, they produced satisfactory stability and flow values and desirable voids content. **The Asphalt Institute, CE-12, Asphalt Institute Bldg., Campus—University of Maryland, College Park, Md.**

Concrete Anti-Freeze

THE PLACEMENT OF CONCRETE at below freezing temperatures has always been an extremely costly adjunct to winter construction operations, in many cases prohibitively so. A new firm recently announced the development of a liquid chemical admixture which guarantees the protection of concrete against loss due to freezing temperature conditions. The product, Thermo-Crete, is revolutionary but not wholly new. Actually, under the name of Pyramid, it has been on the market as a waterproofing compound for nearly 20 years, and more than one million gallons have been used on commercial, industrial and defense projects.

A little over a year ago, experiments with the product led to the discovery that in addition to it being an excellent waterproofing compound, the product had the amazing characteristic of being able to hydrate concrete at sub-zero temperatures. So amazing are the characteristics produced by Thermo-Crete in concrete, that a new name, Thermo-Concrete, was given to concrete containing the admixture. This in turn, has produced a whole new dimension in concrete placement and curing. It is now possible to place concrete at temperatures as low as —30 deg F without the need for mechanical heating or covering. Compressive strengths are gained over longer periods of time

(Continued on page 132)



STRENGTH was the first requirement for a 4,000 foot drainage structure under the new east-west runway at Greater Pittsburgh Airport. Precast concrete Hi-Hed pipe provided this essential strength (50% stronger on the average than equivalent size round pipe), plus a big bonus in the form of an estimated saving of $150,000—approximately 18% savings over competitive material.

Versatile A-M Hi-Hed Pipe is designed for minimum vertical load and maximum lateral support . . . saves trench width in congested areas . . . is readily available in sizes up to 144″ round pipe equivalent from plants strategically located throughout the nation. Write today for illustrated Hi-Hed brochure.

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CONCRETE PRODUCTS DIVISION
GENERAL OFFICES:
AMERICAN-MARIETTA BUILDING
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MODEL 555

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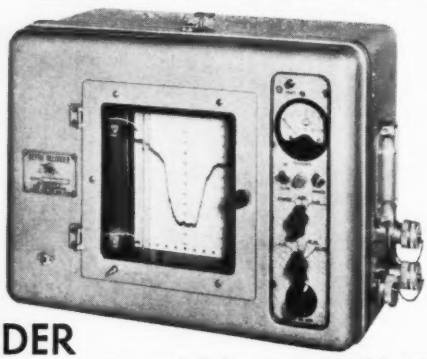


Improved design of new Model 555 Survey Depth Recorder means greater accuracy, ready accessibility of all components for maximum servicing ease.

EDO, world leader in hydrography, presents the new Model 555 Survey Depth Recorder, incorporating numerous mechanical and electrical advances in the technique of echo-sounding survey.

Research and development undertaken for the U.S. Navy have resulted in the complete re-design of Edo's pioneering Model 255 Survey Depth Recorder. The new Model 555 is already being delivered in quantity to the Navy for upward-looking scanning by submarines submerged beneath ice, as well as for bottom scanning.

Light in weight (only 55 lbs.), easy to operate and extremely accurate, Model 555 is suited to temporary or permanent installation aboard vessels of every size. The new superheterodyne receiver assures sharp, precise recordings, while Edo's new Model 480 transducer, a barium titanate block type, improves sensitivity and definition 100 per cent.

Model 555 gives permanent readings on over-lapping range scales from 1½ feet to 230 fathoms. The wide transducer beamwidth—20 degrees at minus 10 db points—provides excellent penetration and broad coverage for all types of general underwater survey.

Send for brochure, Dept. V-4.

Edo CORPORATION, College Point, L. I., N. Y.

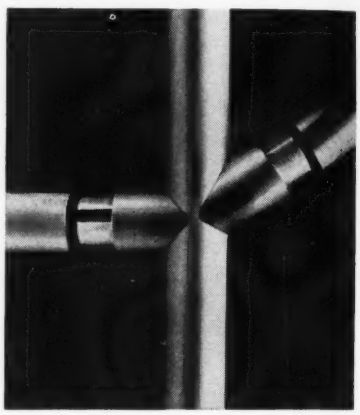
EQUIPMENT MATERIALS and METHODS

(continued)

than normally expected. Thermo-Concrete has a high resistance to corrosion and heat. **Thermo-Crete Corp., CE-12, 426 So. Spring St., Los Angeles 13, Calif.**

Pipe Railing System

"CONNECTORAIL," A COMPLETE NEW SYSTEM of wrought aluminum fittings, permits economical construction of flush-



type pipe railings, without welds or exposed fasteners. Assembly is easier and faster than with older systems, and economy is achieved through the elimination of welding operations and the employment of lightweight Schedule 10 pipe. The new connectors allow perfect color matches with pipe, even after alumiliting. Structural soundness and proper alignment are enhanced, since posts and top rails run in continuous lengths, uninterrupted by cross and tee fittings.

All components for the new system are carried in stock, both for 1¼ in. and 1½ in. pipe. Components are available for all common conditions and stair angles, and are furnished either with smooth mill finish or etched and alumilited. The complete system includes tees, elbows, floor and fascia flanges, connector sleeves, brackets, wall returns and plugs. **Julius Blum & Co., Inc., CE-12, Carlstadt, NJ.**

Portable Dredges

A SERIES OF EXCLUSIVE design refinements has been standardized into the "Dragon" line of portable dredges. Introduced to meet the need for greater mobility and versatility in dredging equipment, the compact Dragon line has, for nearly 10 years, undergone rigid testing around the world on road construction,

(Continued on page 133)

EQUIPMENT MATERIALS and METHODS

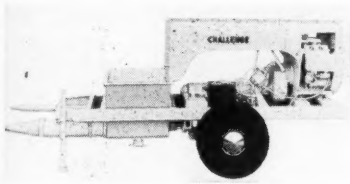
(continued)

land reclamation, industrial anti-pollution, waterway maintenance, harbor improvement, beach erosion, swamp drainage and other projects. Completely electro-hydraulically operated with unified fingertip controls to facilitate handling ease and lessen operator fatigue, these portable dredges are available in varying sizes.

A major design feature is the patented two-piece hull which disassembles quickly for transfer by truck or rail car from one job site to another and permits reassembly either ashore or in the water. The hull itself is rectangular in shape to provide maximum flotation, safety, and resistance to cutter torque. Work-stopping damage from cave-ins of rock and debris is eliminated because no important machinery, including hydraulic cutter motor, is under water. All hull connectors are located above the water-line, assuring against all hull leaks of any sort. **Ellicott Machine Corp., CE-12, Baltimore, Md.**

Time Saver

THIS NEW GROUT PUMP is a rugged, heavy duty machine which will pump up to 20 cu yd of material per hour, hoist material more than 10 stories high and pump material over 300 ft horizontally. It is a valuable time and money saver in grouting and hoisting operations as well as in concrete placement.



"Grout King"

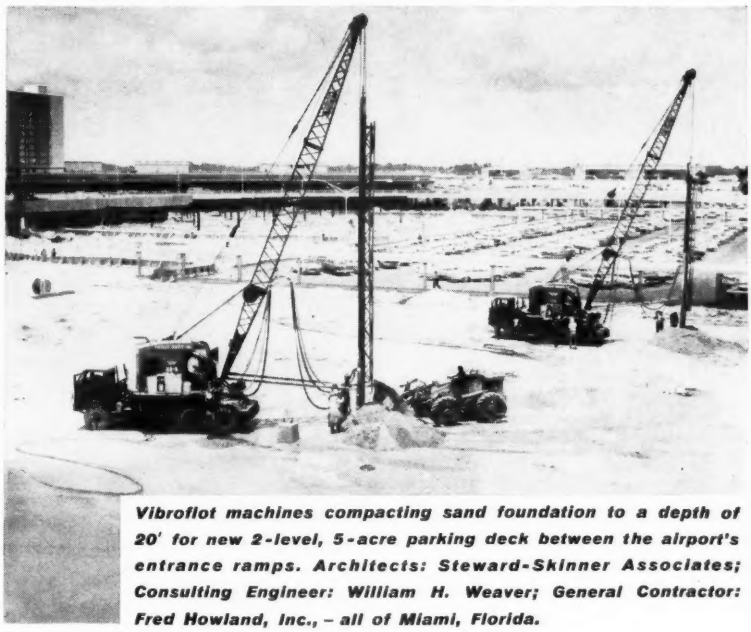
The "Grout King" is powered with a 30 hp air cooled engine equipped with an electric self-starter as standard equipment. It has a 3-speed transmission with one reverse gear to assist in clean-out work. The "Grout King" is trailer mounted and is easily towed from job to job. **Challenge-Cook Bros., Inc., CE-12, 3334 San Fernando Road, Los Angeles 65, Calif.**

Tower Crane

A NEW ELECTRIC POWERED TOWER CRANE, the first American-built machine of its type, has been developed for use

(Continued on page 134)

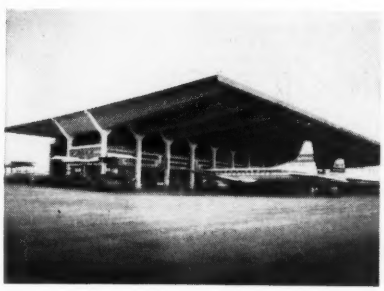
8th major project by Vibroflotation®
at Miami International Airport



Vibroflot machines compacting sand foundation to a depth of 20' for new 2-level, 5-acre parking deck between the airport's entrance ramps. Architects: Steward-Skinner Associates; Consulting Engineer: William H. Weaver; General Contractor: Fred Howland, Inc., – all of Miami, Florida.

Other projects at Miami International Airport

National Airlines	(1) Administration Building
	(2) Cantilever Hangar
Delta Airlines	(3) Loading Pier
	(4) Maintenance Hangar
	(5) Fuel Tanks
American Airmotive Corp...	(6) Cantilever Hangar
Miami Skyways Motel	(7) Deluxe Motel



Cantilever hangar pictured at left was project No. 2 for National Airlines. Architect: Weed, Russell, Johnson and Associates, Miami; Consulting Engineer: Ammann & Whitney, New York; Soil Consultant: D. M. Burmister, New York; Contractor: Fred Howland, Inc., Miami.

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on multi-story building erection and major construction projects. Designated the Mark I-50, it is designed to handle building-construction crane applications with a marked reduction in labor and materials handling costs. With its flexible, building-height tower and 60 to 120-ft boom lengths, the crane provides both vertical and horizontal liftability in one continuous cycle. Under average conditions, it can pour up to 50 cu yd of concrete per hour.

All four basic functions of this materials handling giant, swing, load hoist, boom hoist and propel, can be operated independently or simultaneously. The operator can position his cab in the tower at a level providing best visibility of the work area.

Applied to major building construction, the crane can effect a sizeable labor saving through its ability to place loads without rehandling. Its load carrying ability and fine hoisting control are ideally suited for steel setting jobs or other extremely precise work. It can be used economically wherever large work or storage areas must be dominated, particularly where conventional crawler or truck cranes are limited by the height or depth of a structure, or by the space in which to move around or maneuver. **Bucyrus-Erie Co., CE-12, South Milwaukee, Wis.**

Off-Highway Haulers

WITH THE INTRODUCTION of the Model 42 and the Model 60 end dump trucks, the Haulpak line now covers the entire size range for off-highway haulers, from

Haulpak 60

the 22 ton to the largest, new 60 ton truck. Although the Model 60 is one of the world's largest end-dumps, by utilizing extra high yield strength steels and fabricated units in construction, it weighs only 33 tons. Yet it is capable of hauling a pay-load almost twice its own weight. Powered with a 550 hp Cummins, V-12 Turbocharged Diesel engine, and a Torqmatic transmission with 6 forward speeds, it has a top speed of 46.6 mph. The Model 42 is powered with a 430 hp Cummins, V-8, Turbocharged engine and the 6 speed transmission. It is capable of a top speed of 47.7 mph.

This new off-road hauler has many unusual features. It was built to be more rugged, and less complicated and troublesome than conventional trucks built with "automotive-type" assemblies; these were eliminated entirely or replaced by tougher "earthmover-type" components. Conventional axles and springs have been eliminated by the use of an exclusive "Hydrair" suspension system. There are no tie rods or exposed steering linkage, the steering system being protected above or within the frame, giving this truck almost twice the ground clearance of conventional vehicles. It is easy and safe to handle, with full power steering and power brakes. **LeTourneau-Westinghouse Company, CE-12, 2301 N.E. Adams St., Peoria, Ill.**

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TRANSITE[R] PIPE—Transite[R] Sewer Pipe, made of asbestos-cement, is available in 11 different diameters ranging from 6 in. to 36 in. and in 5 crushing strengths to permit greater efficiency in system design. Ring-Tite[R] Coupling, designed for high-speed assembly, provides tight, long-lasting seal. Easy-to-assemble Transite sewer fittings with Ring-Tite assembly also furnished. Complete information is available from brochures TR-165A (Transite Sewer Pipe), TR-94A (Sewer Design Flow Chart), and DS-366 (Transite Specifications). **Johns-Manville Corp., CE-12, 22 E. 40th Street, New York 16, N. Y.**

WATER CONTROL EQUIPMENT—The answer to your water control problems can be found on the pages of this Water Control Equipment Catalog. Included are sections on: Sluice Gates; Hoisting Equipment; Fabricated Metal Gates; Fabricated Wood Gates; Valves, Regulators, Racks, Rakes, Screens; Engineering Data & Tables, and Manufacturing Facilities. Write on your company letterhead to obtain a copy of this 212-page catalog. **Rodney Hunt Machine Co., Water Control Equipment Div., CE-12, 7 Lake Street, Orange, Mass.**

TORQUE MANUAL—The third and completely revised edition of the Torque Manual has 31 pages of application illustrations, bolt charts, discussions on assembly characteristics, instructions for torque wrench testing, pictures of modified and special torque wrenches, formulas and illustrated explanations for using adapters, attachments and extensions. There are instructions for properly caring for a torque wrench and 6 pages of illustrations and easy to understand explanations on using it correctly. **P. A. Sturtevant Co., CE-12, Addison, Ill.**

CONSTRUCTION MATERIALS—A new, 4-page booklet describing Durajoint[R] PVC masonry control joints, masonry and brick or block expansion joints, and water-stops, has just been published. Other construction materials such as Rodofoam[R] joint filler and Rodofix[R] weather-and-water-proof sealing compound are shown. The booklet is fully illustrated with drawings of typical installations and cross-sectional diagrams of its unique multiple-rib design. Similar illustrations are used in presenting the new Durajoint 20 and 21. **Electrovert Inc., CE-12, 124 East 40th Street, New York 16, N. Y.**

PLATFORM TRAILERS—Features of this company's platform trailers are described in a 4-page folder, bulletin 104E. Included also are Lowbeds and Totem-All trailers. **Birmingham Manufacturing Co., Inc., CE-12, First Ave. and South 55 St., Birmingham, Alabama.**

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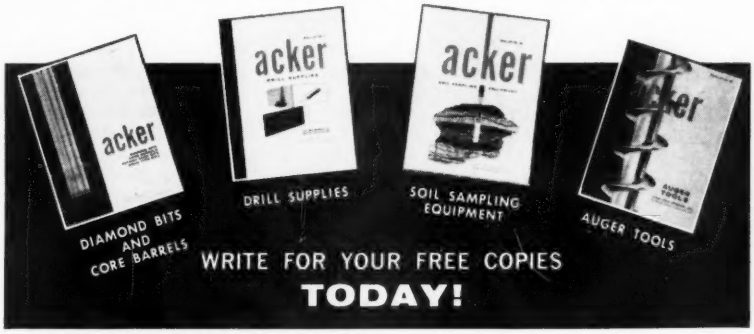

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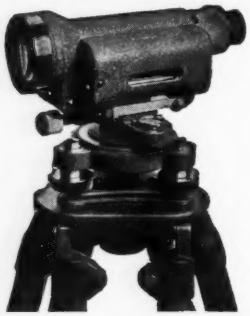

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Literature Available

STRUCTURAL LOADING SYSTEMS—A structural loading systems notebook is offered by this company. Included is a description of a typical system constructed from components manufactured by the company, followed by general specification sheets and diagrams of the various components. **CompuDyne Corp., CE-12, 400 South Warminster Road, Hatboro, Pa.**

NUCLEAR POWER PROGRESS CHART—A new "progress chart" showing the major industrial participants involved in 39 nuclear power projects in the United States and abroad is now available. Printed on a 22x29 in. sheet, it contains such data as: Owner/Operator, Location, Type, Fuel, Power Level, Completion Date, Architect-Engineer of Reactor System, Constructor, Core/Fuel Element Supplier, etc. Data is broken down according to: projects in operation, under construction, under pre-construction development, under contract negotiation and announced. Single copies are available for $1.00. **Atomic Industrial Forum, CE-12, 3 E. 54th St., New York 22, N. Y.**

RATEDAERATION—The small unit sewage treatment process equipment described in this bulletin is good for 20 to 5,000 people. The process, called RATEDAERATION, is a balanced application of the aerobic digestion theory employing the principle of endogenous respiration, proven highly successful in actual usage. Two different plants are presented in the bulletin: a concrete plant for 75 to 5,000 people, and a steel tank for 20 to 400 people. Also included are charts of typical performance data and representative installations. **Chicago Pump, Hydrodynamics Division, Food Machinery and Chemical Corp., CE-12, 622 Diversey Parkway, Chicago 14, Ill.**

CONCRETE FLOORS AND ROOFS—According to the manufacturer, the self-forming floor and roof system described in this booklet combines the advantages of both pre-cast and cast-in-place methods of concrete floor construction and, by eliminating their disadvantages, offers a major contribution to all-round economy and efficiency in the construction of floors and roofs. Both the joists and blocks are precast under controlled mass-production methods to assure the best in quality at an economical cost. The concrete poured over the assembled joists and blocks forms a continuous, monolithic structure. **Omnia Industries Inc., CE-12, 51 East 42nd Street, New York 17, N. Y.**

CONCRETE FLOOR TOPPING—A 4-page bulletin explains how a Synthanite-sand-gravel concrete floor topping floats over the structural sub-floor. Included are illustrations of 7 systems using this new concept. **American Synthanite Corp., CE-12, 99 Park Ave., New York 16, N. Y.**

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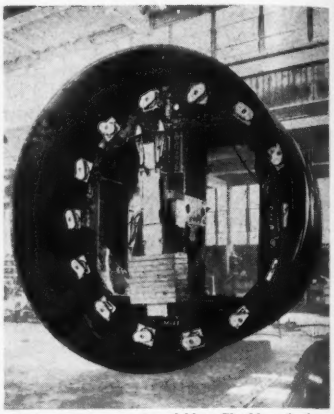

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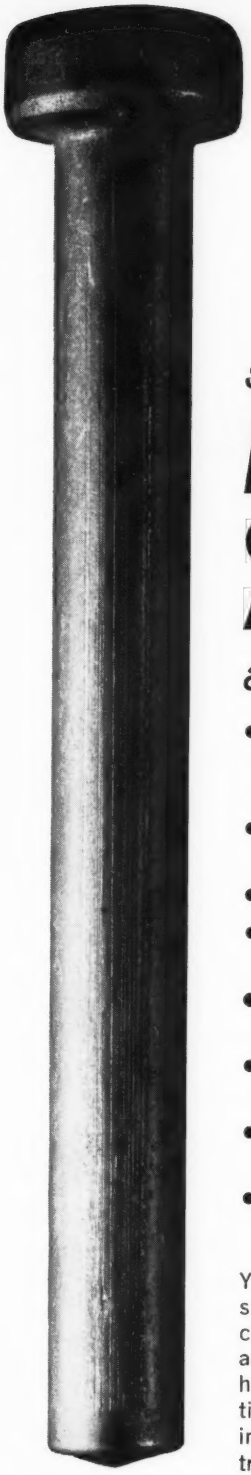
From the MANUFACTURERS

HONORARY DEGREE: At the dedication convocation for the new Engineering-Science building at the University of Toledo, Roy A. Nyquist, director of engineering of Libbey-Owens-Ford Glass Co., received the honorary degree of Doctor of Engineering conferred by Dr. William A. Carlson, president . . . **SALES-SERVICE SCHOOL:** The Koehring Export Division of Koehring Co. held a two week sales and service school at its Proving Grounds near Waukesha for about 20 distributor representatives from 18 countries. The purpose of the school was to provide foreign distributor personnel with the latest sales and service information about machines manufactured by the company . . . **CITATION:** Peoria manufacturer, LeTourneau-Westinghouse Co., has been awarded a citation for "outstanding achievement in military ground support equipment." . . . **ACQUISITIONS:** After one year as International Distributor of Superior Cement Finishers under the name of Essick-Superior Finishers, Essick Manufacturing Co. has announced the acquisition of the Superior Cement Tool Corp. of Lynwood, Calif. . . . Sturtevant Mill Co., Dorchester, Mass., has acquired the manufacturing rights to the Underwood Sand Spreader, widely used for snow removal and ice control. Charles N. Wood Co., Watertown, Mass., will continue to act as sales agent for the sand spreader in the northeast . . . Dictograph Products Inc. has acquired all of the outstanding stock of Edward P. Casey Sound Systems Inc., N. Y. C., and will operate it as a wholly-owned subsidiary under the name of Casey Dictograph Systems Inc. Edward P. Casey will remain as head of the new company . . . **DEDICATION CEREMONIES:** Formal dedication ceremonies were held at the new AEROTRON plant in Raleigh, N. C. The company is a major producer of two-way radio communications equipment . . . **NEW APPROACH:** A new approach to the problem of residential construction, combining suburban comforts and amenities with urban conveniences, was announced by Logan T. Johnston, president, Armco Steel Corp. Carl Koch & Associates, Cambridge, Mass., have been retained by Armco to design a multiple-family, garden-type apartment dwelling "making maximum intelligent use of steel." . . . **NEW PLANTS:** This month, Precision Transformer Corp. will occupy its new 50,000 sq ft building in Elk Grove Village, Ill. . . . Kohler engines and electric plants, used in construction, industry, agriculture and other fields, are now being manufactured in a newly completed factory building in Kohler, Wis. . . . Robertshaw-Fulton Controls Co., manufacturers of appliance, industrial and military controls, opened a new Robertshaw Theromstat Division manufacturing plant near Pittsburgh, Pa. . . . Foundation construction is underway for an 84,000 sq ft Trane Co. plant at Kearns, Utah, where the company will manufacture ventilating and heating equipment . . . A new warehouse will be built by the York Division of Borg-Warner Corp., in York, Pa., to afford better control of shipping and storage and eliminate transportation to and from several rented areas in the city . . . **NEW NAME:** Dryer Electric Corp., manufacturer of tubular centrifugal and axial-centrifugal fans, has changed its name to Dryer Dynamics Corp. The company has moved to a new, larger plant in Lyndhurst, N. J. . . . **NEW DIVISION:** Hewitt-Robins has announced a new division, Union Chain, Sandusky, Ohio, manufacturers of roller and conveyor chain . . . **BRANCH OFFICE:** Porta House, builder and distributor of prefabricated portable field offices and tool sheds, is opening a new branch office and service yard in Los Angeles, for faster Southern California service . . . **APPOINTMENTS:** Edward J. Hart, a veteran of 20 years' sales and engineering experience in the field of electronics, has been appointed Manager of the Radio Corporation of America Microwave Department . . . Dale W. Heineck has been appointed manager of Alpha Portland Cement Co.'s newest cement plant at Lime Kiln, Md. He succeeds George V. Cosgrove who has been promoted to manager of process engineering at the company's Easton, Pa. home office. . . . OPW-Jordan Corp. has announced the promotion of R. J. Peters to Manager of Product and Market Research.



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Journals: Structural, Construction, Hydraulics, Sanitary Engineering, Waterways and Harbors.

2637. Use of Continuity-Factor and Final Position, by Yon-Sun Chou. (ST) The purpose of this paper is to introduce the use of continuity-factor and final position in the analysis of any continuous structures of simultaneous, one-direction, sway-movement, especially as applied to multi-bay, multi-story rigid frames. Such a structure or frame will be analyzed by the method of computing unbalanced moments, for which purpose a simple, clear procedure of analysis is obtained from the previously mentioned factor. A few examples are also presented.

2638. Corrected Deflection Theory of Suspension Bridges, by John Szidarovsky. (ST) This paper presents a deflection tion theory of a stiffened suspension bridge that considers several effects neglected in previous theories, such as those due to shear force and to elongation of the cable. Only the theory, and not a practical method of solution, is dealt with.

2639. Soil Freezing to Reconstruct a Railway Tunnel, by George J. Low. (CO) Allowing for track rearrangements in a railway tunnel in Montreal, Canada, called for considerable ingenuity on the part of the contractors. The job was made especially difficult by the maze of underground facilities and the fact that the work had to be performed under the street between the two buildings. The subsurface conditions were such that the freezing of the soil was resorted to. The problems attendant to such a construction procedure are outlined.

2640. Research on Fire Resistance of Prestressed Concrete, by Hubert Woods. (ST) The need for research on fire endurance of concrete structural members is pointed out, and new facilities for such research are described. Some problems awaiting solution are treated, and difficulties in reaching analytical solutions are mentioned. Questions regarding present standard fire-testing techniques are also treated.

2641. Activated Carbon Removal of Hydrogen Sulphide, by R. S. Murphy and I. W. Santry. (SA) The removal of hydrogen sulphide from an air gas mixture presents many problems. This paper deals with the removal by one media only (activated carbon), but considers the many types of conditions that could occur, as well as the basic conditions that are created during the dynamic chemisorption.

2642. Bank Protection on Central Valley Streams, by H. W. Barsdale. (WW) Bank protection is an important adjunct to flood control and navigation projects in the central valley of California. The corrective measures that have generally proven satisfactory for the various types of channels varying from the tidal waters to the foothill streams are described.

2643. Principles of Virtual Work in Structural Analysis, by Frank L. DiMaggio. (ST) The principle of virtual work is derived for plane structures composed of straight members to permit a general interpretation of the function usually called "virtual displacement" and is applied to the determination of deflection in elastiplastic structures, and to the problems of deriving equilibrium equations.

2644. Flood-Frequency Relationships in the Pacific Northwest, by G. L. Bodhaine. (HY) This paper describes, in general terms, a method of determining the magnitude and frequency of expected floods that is applicable to any area in the Pacific Northwest of the United States. The development of a composite frequency curve applicable to any site in a large homogeneous region is examined, and the effect of mean elevation and size of drainage area on the shape of the frequency curves in designated parts of the Pacific Northwest is demonstrated.

2645. Load Distribution in Composite Girder-Slab Systems, by G. Hondros and J. G. Marsh. (ST) A series of simply-supported composite girder-slab systems embracing five and ten girders interconnected by a reinforced concrete slab was tested, from which confirmation of certain assumptions made in the design of a prototype bridge was sought. Comparisons between actual and theoretical behavior are made and the effect of skew angle of the bridge and torsional stiffness of the girders are assessed.

2646. Periodical Gravity Wave on a Discontinuity, by Bernard Le Méhauté. (HY) A general theory is presented to study the transmission and reflections of gravity waves on a discontinuity to the first order of approximation. Particular attention is given to cases of an obstruction, a change of width, and a change of depth. In the latter case only, the gravity wave arriving at an angle is studied.

2647. Russian River Channel Works, by Israel H. Steinberg. (WW) The paper presents evaluations of channel stabilization works constructed in 1956, by the U.S. Army Corps of Engineers, San Francisco District, along a 4 mile test reach of Russian River, California. From

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observations of this work, tentative conclusions are reached that the works performed as planned and could be adapted to other reaches of Russian River.

2648. Hydrology and Flood Control Features at Oroville Dam, by Joseph I. Burns, Kenneth B. Mayo, and William A. Arvola. (WW) Oroville Dam, a 735 ft-high, zoned earthfill dam, is proposed for construction by the State of California on the Feather River, a major tributary of the Sacramento River. A summary of the hydrologic and meteorologic characteristics of the Feather River Basin and the hydrologic studies pertaining to the design floods for the project are presented. The preliminary spillway design concepts and proposed operating criteria are also discussed.

2649. Sacramento River Deep Water Ship Channel, by Amalio Gomez. (WW) This paper describes the functional planning studies made for the Sacramento River Deep Water Ship Channel, now under construction by the Corps of Engineers. This paper includes a description of the project, functional requirements, hydraulic studies, estimates of benefits, and comparison of benefits of costs.

2650. Shear Diaphragms of Light Gage Steel, by Arthur H. Nilson. (ST) It is recognized that the diaphragm strength of floor and roof elements of buildings can be utilized to resist horizontally-applied loads, eliminating the need for separate bracing systems. With proper attention to welding details, floors and roofs of light gage steel panels, designed primarily to carry vertical loads, will be effective as shear diaphragm. Extensive full-scale tests of light gage steel diaphragms are described and test results are interpreted.

2651. Statistical and Economic Analysis of a Bidding Trend, by Marvin Gates. (CO) Almost four hundred results of bids for heavy construction contacts are analyzed for correlation between the size of the contract and the difference between the low and second bids. The results of this analysis are applied to four diversified areas of competitive bidding. They are that: another criteria for ascertaining the probable existence of a gross mistake in a bid is offered; a suggested maximum amount of bid guarantee is treated; the practice of using "going" prices is investigated, and three methods for increasing profits, based on probability factors, are described.

2652. Water Eddy Forces on Oscillating Cylinders, by Alan D. K. Laird, Charles A. Johnson, and Robert W. Walker. (HY) Neighboring cylinders may increase drag force on vertical cylinders by 75% or decrease it to minus 20%, and may triple lift forces, for spacing to 3 diameters and cause significant deviations to 10 diameters. Neighboring cylinder eddies cause large force fluctuations.

2653. Flume Studies of Flow in Steep, Rough Channels, by Dean E. Peterson and P. K. Mohanty. (HY) Based on observations of both natural streams and flume experiments, three classifications of flow in steep, rough, open channels are proposed: tranquil, tumbling, and rapid. The tranquil and rapid regimes are dominated by subcritical and supercritical flow, respectively. In the tumbling regime, the roughness elements induce supercritical flow over their crests followed by individual hydraulic jumps to the tranquil state. The characteristics of flow in each of the proposed regimes are described, and criteria for delineating the regimes are proposed.

2654. Simply Supported Corner Plates, by Mario G. Salvadori and H. C. Reggini. (ST) A corner plate, simply supported on two parallel boundaries, each composed of two semi-infinite straight lines meeting at right angles, is uniformly loaded. Bending and twisting moments and shears and boundary reactions in the plate are determined by finite-difference integration of the corresponding boundary value problem. The penetration into the side strips of the disturbance represented by the corner is shown to be practically negligible at a distance from the inner corner of the width of the side strips.

2655. Tests on Prestressed Concrete Embedded Cylinder Pipe, by Hugh F. Kennison. (HY) This paper presents the results of the first full-scale pressure and external load tests ever made in 60 in. prestressed concrete embedded cylinder pipe designed according to AWWA Specification C301. The structural behavior of this pipe under combined loads is reported, based on the development of stress cracks in the concrete and on strain recordings from SR-4 strain gages.

2656. Translations of Foreign Literature on Hydraulics, Third Progress Report of the Task Force on List of Translations of the Committee on Hydromechanics of the Hydraulics Division. (HY) In an attempt to bring to hydraulic engineers an up-to-date listing of translations of foreign literature on hydraulics, it is the intent of the task force preparing this report to issue, from time to time, progress reports containing suitable items. The present list is the third issued since the publication, in 1957, of ASCE Manual 35, entitled "A List of Translations of Foreign Literature on Hydraulics."

2657. Investigation of the Corrosive Behavior of Waters, by Werner Stumm. (SA) An interpretation is given to specific corrosive results obtained in field and laboratory investigations. The complex mutual interaction of corrosion stimulating and inhibiting factors (pH, buffer capacity, $CaCO_3$ deposition, and alkalinity) is treated.

2658. Design Considerations for California Marinas, by James W. Dunham. (WW) Considerations and criteria for the functional layout and structural design of marinas for small craft, as proposed by the California State Division of Small Craft Harbors, are presented. Examples of successful design practice are given, and recommendations are made for use of various types of material and design under different conditions of exposure.

2659. Discussion of Proceedings Paper 2175, 2318, 2422, 2507, 2528. (WW) John M. Weiss and Virgil Blancato on 2175. Basil W. Wilson on 2318. J. Th. Thijsse and W. D. Baines and H. J. Leutheusser on 2422. Robert E. Hickson and J. E. Deigman on 2507. Donald C. Hill on 2528.

2660. Tritium as a Ground Water Tracer, by W. J. Kaufman. (SA) Tritium is the form of tritiated water in a nearly perfect ground water tracer. Its only serious disadvantage is derived from its radioactive properties and the potential effects on public health of extremely small concentrations of radioisotopes. The potential biological risks of using tritium in large scale water tracing operations are treated and compared with the possible benefits.

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CIVIL ENGINEERING, December 1960, Vol. 30, No. 12 • Published monthly by the American Society of Civil Engineers. Publication office Concord, New Hampshire. (Second class mail privileges authorized at Concord, New Hampshire.)

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Co., General Contractors, New York City, starting at adjacent corners and working across the top of the building. Two cranes supplied the POZZOLITH ready-mixed concrete from the American Hard Wall Plaster Co., Utica, as the crews worked their way across the top of the structure. At 5 p.m., another crew and crane joined in, and shortly after midnight placing was completed. During the 16-hour, continuous concreting operation—approximately 360 cubic yards of concrete were placed in the intricate forms . . . and POZZOLITH helped assure a truly monolithic structure by retarding the hardening of the mix to eliminate cold joints.

Seven-day breaks on test cylinders averaged 4200 psi, 14-day breaks averaged 4985 psi and 28-day breaks averaged 5665 psi. Two weeks later, the girder was post-tensioned by Pre-Stress, Inc., of Albany, employing the P.I. system of anchorage.

POZZOLITH concrete was used throughout this building—from the intricate lattice-work of cast-in-place concrete ribs which spans the central bay, to the massive walls of lightweight concrete which seem to float on a ribbon of glass at grade level. The hung balcony around the perimeter of the interior and its cantilevered reinforced concrete stairway also contain POZZOLITH.

Utica's Munson-Williams-Proctor Institute Art Gallery stands as a unique and significant engineering achievement, and an example of the great utility and versatility of modern POZZOLITH concrete, one of today's most economical and exciting building materials. It is also evidence of the benefits of close cooperation between creative architects and engineers, and the suppliers and builders who turn their designs into realities.

POZZOLITH and Master Builders Field Service—From early planning through completion of the job, the consulting engineers, contractor and ready-mix producer had the full cooperation of the Master Builders field men. These experienced field men utilized Master Builders technical products and know-how to achieve uniform concrete of superior quality, at lowest cost-in-place.

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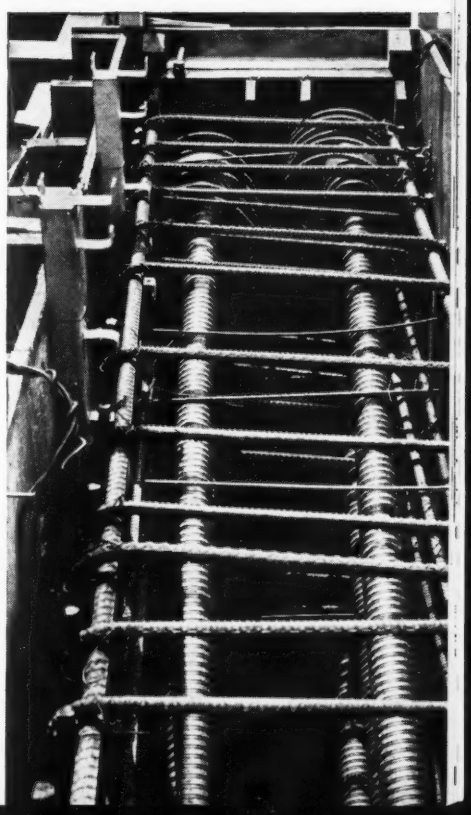
GALLERY

HUGE PRESTRESSED MONOLITHIC GIRDER—The structural system, weighing 720 tons, and containing over 360 cubic yards of 5000 psi concrete was cast-in-place 50 feet above grade. The girder supports roof and hung balcony without interior columns. Facade will be covered with black Canadian granite, while girders and their supporting columns will be sheathed in bronze.

THE MAZE OF REINFORCING STEEL and 14 flexible conduits for the post-tensioning cables made high workability a must in the concrete mix design. Use of POZZOLITH permitted a sharp reduction in water content, yet gave a highly workable mix with 3½" slump.

THE MUNSON-WILLIAMS-PROCTOR INSTITUTE ART GALLERY was designed by architect Phillip Johnson and engineered by Dr. Lev Zetlin, both of New York City. Supervising architects were Bice and Baird of Utica. The George A. Fuller Company, New York City, built the art gallery, with Jack Madden as project supervisor and William Gardner as engineer. The American Hard Wall Plaster Company, Utica, supplied the POZZOLITH ready-mix concrete. Pre-cast roof sections were supplied by Schenectady Concrete Products. Post-tensioning was by Pre-Stress, Inc. of Albany.



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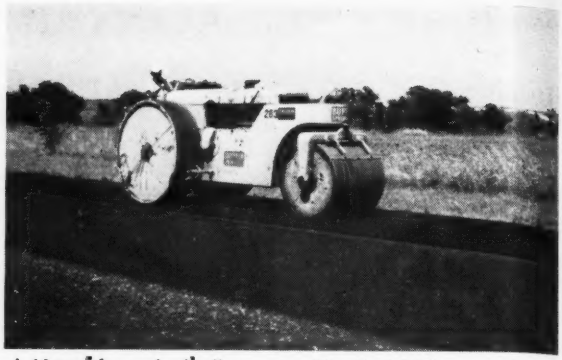
Laying 3½ inch leveling course of plant-mixed Texaco Asphaltic Concrete over old pavement on US 81 in Texas.



A 10-ton three-wheel roller was used for the initial compaction of both the asphalt leveling course and asphalt surface.

This 10-ton pneumatic tired roller gave final compaction of the two asphalt courses.

New Texaco Asphaltic Concrete overlay on US 81 substantially strengthened this highway at moderate cost.

How Texas strengthened old highway at moderate cost with Asphalt overlay

Traffic on US Route 81 north of Georgetown, Texas, has increased to 5,100 vehicles a day — too heavy a load for the highway's old, rough pavement. The method the state used to solve this problem combined speed with economy.

First, a leveling course of plant-mixed Texaco Asphaltic Concrete was laid over the old pavement to an average thickness of 3½ inches. Aggregate used in this course passed a 2½ inch screen. This was topped by a one inch wearing surface of Texaco Asphaltic Concrete, using an aggregate passing a ⅝ inch screen. The crushed limestone and field sand, which were blended with the asphalt, provided a high-stability mix for this overlay.

Since it is resilient, a plant-mixed Texaco Asphaltic Concrete pavement such as Texas laid on US 81, will absorb and weather heavy impact year in and year out. Also contributing to this pavement's durability and low upkeep cost are its immunity to salts, which are used in northern areas of the United States to melt ice and snow, and its freedom from expansion joints which eventually lose their alignment.

Besides the heavy-duty Texaco Asphaltic Concrete pavement pictured here, there are several other plant-mixed types of Texaco Asphalt construction for highways, streets, airports and parking areas. These types, which vary in durability and cost, include one which will fit your paving requirements exactly. If you would like helpful information on the methods and materials recommended for all of these pavement types, write us. No obligation.

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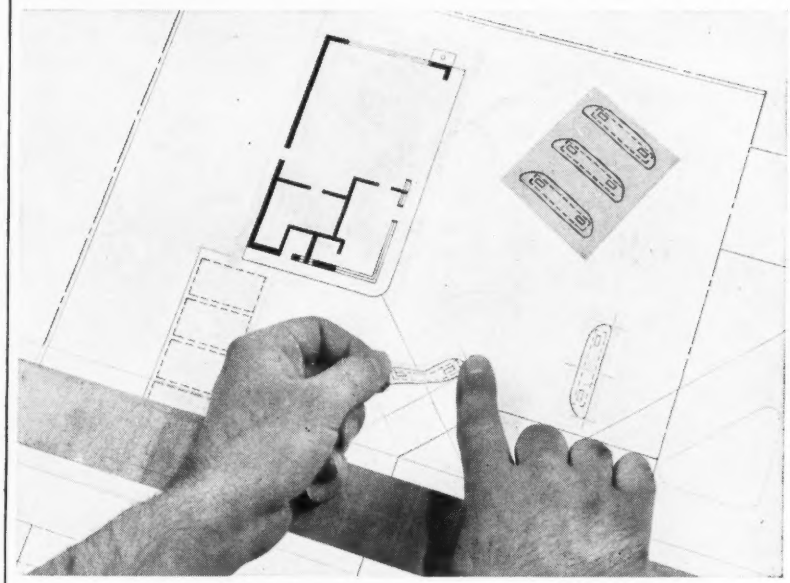

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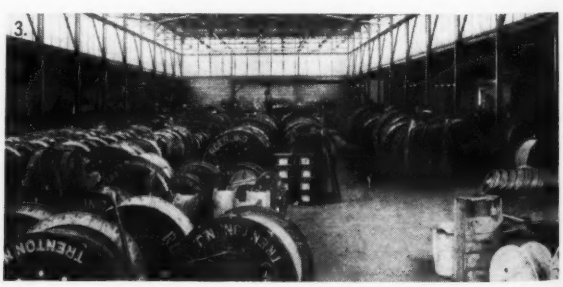
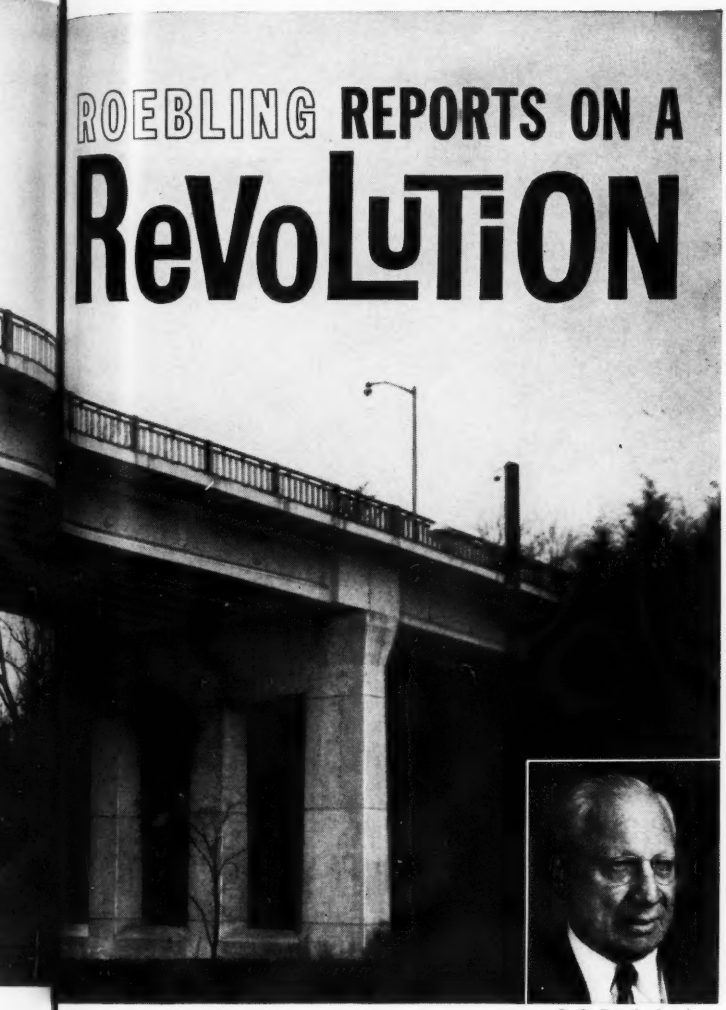
1. Walnut Lane Bridge, Philadelphia, Pennsylvania. David M. Smallwood, Street Commissioner, City of Philadelphia, states, "The Walnut Lane Bridge, completed in 1950, represents the first major prestressed concrete bridge built in the United States and, as such, is the emblem of a thriving industry. We are proud to have this bridge in Philadelphia. It is an excellent example of economical, functional and aesthetic bridge construction. During the past 10 years it has required virtually no maintenance and we confidently expect that it will serve our citizens for many more years to come." The Walnut Lane Bridge was designed by The Bureau of Engineering, Surveys and Zoning, City of Philadelphia, assisted by Charles C. Zollman, then of Preload Enterprises. This latter firm was subcontractor for construction of the prestressed girders working under the general contractor Henry W. Horst Co. Stress-relieved wire, developed and produced by Roebling specifically to meet the requirements of prestressed concrete, was used for the first time on this project. The strength of this wire was considerably higher than any used previously.

2. Turkey Creek Bridge (prestressed block-beam construction), Madison County, Tennessee. First prestressed concrete bridge in the United States, built in 1949. Harley A. Baker, Engineer, Madison County Highway Department, Jackson, Tennessee, states that maintenance on this bridge has *cost nothing*. As for strength, loads as high as 40 tons cross the bridge frequently and, in the words of Mr. Baker, "The bridge takes these loads fine." Designed by Bryan & Dozier, Consulting Engineers, Nashville, Tenn. Built by maintenance forces under supervision of Edwin C. Rogers, Madison County Engineer. Engineering assistance on this bridge and tensioning materials were provided by Roebling.

3. Roebling Warehouse Floor, Chicago, Illinois. This was a Roebling research project set up in the very early days of prestressed concrete. Completed in 1946. As a test, half of this floor was laid in the conventional reinforced method and half in prestressed. Fourteen years of heavy reel handling have shown absolutely no signs of wear on



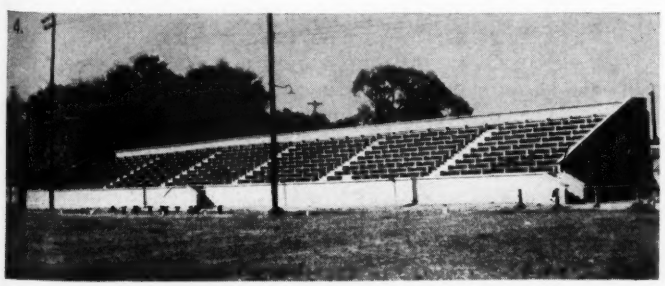
ROEBLING REPORTS ON A REVOLUTION



C. C. Sunderland
1878-1952

prestressed half while the reinforced half, with much less severe use, has required extensive repair. Roebling also produced the first precast prestressed concrete slabs in this country for the deck of the Lumberville Bridge, across the Delaware River. The prestressed deck of the Rio Paz Bridge in Central America was made by Roebling, who engineered all three projects mentioned here prior to 1950.

4. Football Stadium, Central High School, Fayetteville, Tennessee. Designer Ross Bryan of Bryan and Dozier, Consulting Engineers, had the idea that economical prestressed structures could be built in building blocks and used as concrete units. Carroll Strohm, President of Nashville Breeko Block Company, assisted in the research testing of prestressed block beams used here and in the Turkey Creek Bridge. Charles Lindsay, Fayetteville High School Principal, who supervised construction, states that during the 10 years that the stadium has been in use, "there has been no trouble with it whatever." Here again, Roebling furnished the tensioning materials used in the project as well as working closely with the engineers and designers.



These prestressed concrete structures are 10 years old ...They started something that is truly fantastic!

Ten years ago you could count on one hand the number of men in the United States who foresaw the possibilities of this remarkable construction method. In this short span of time their wildest dreams can now be regarded as cautious predictions.

Today, all over the country, prestressed concrete is being used for all types of structures by owners, architects, designers, engineers and builders. Office buildings, terminals, sports arenas, garages, stores, motels, piers, bridges and schools stand in testimony to prestressed's economy, strength, maintenance freedom, fireproofness and aesthetic values.

Much of this growth is due to the vision and untiring efforts of men in civic and professional life who immediately recognized the inherent values of prestressed concrete at first glance. The prime mover of prestressed in this country was the late C. C. Sunderland, former Chief Bridge Engineer of John A. Roebling's Sons Company. His fifty years with Roebling stands as a testament to exceptional ability, vitality and unparalleled vision. His faith in the prestressed method was borne out by the creation of a separate "Prestressed" division within the Company, named Construction Materials Division, just three years after the completion of the Walnut Lane Bridge, the first major prestressed bridge in the country.

The knowledge and experience that Roebling's Construction Materials Division has gained through these years is impressive. We will be glad to share with you data on design and erection, casting bed details, tensioning techniques and materials, and, of course, information on the finest prestressed strand available. For this, write Roebling's Construction Materials Division, Trenton 2, New Jersey.

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Branch Offices in Principal Cities
John A. Roebling's Sons Division
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SWITCH TO KON-TORK DIFFERENTIAL

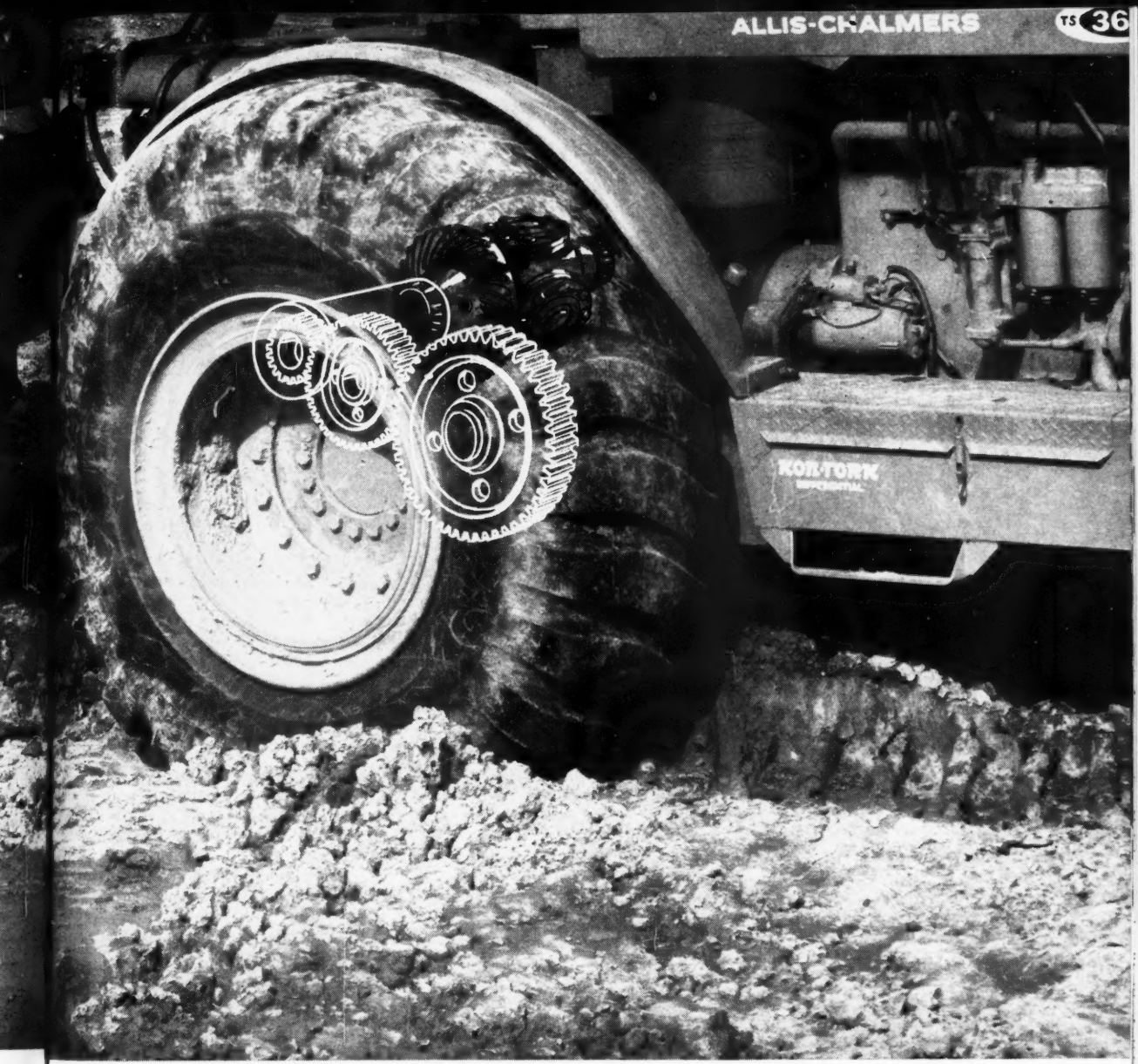
KON-TORK differential provides every Allis-Chalmers motor scraper with maximum traction to match any working condition—provides you with all-weather production.

Only Allis-Chalmers offers exclusive KON-TORK differential in every motor scraper. This traction-boosting benefit makes dirt pay under severe job conditions.

KON-TORK works automatically, whenever it's needed. In the cut, on the haul or soft fill, it helps you by automatically controlling the transfer of torque to each drive wheel . . . giving you the benefit of all available traction *all the time.*

Example: When one drive wheel hits soft going, KON-TORK takes hold and transfers torque from the slipping wheel to the wheel with solid footing to keep the machine moving out. Another nice thing

move ahead with

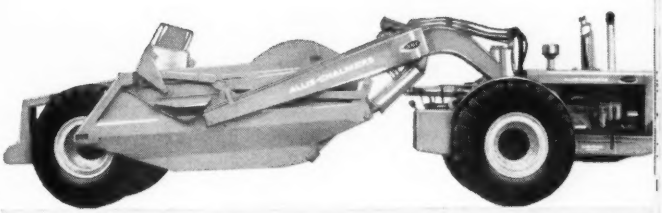


TRACTION MAGIC, EVEN IN MUD

about KON-TORK . . . it's simple! Only five working parts . . . never needs adjustment!

But this is only one of many features that keep Allis-Chalmers motor scrapers out front on every job. You should see what *full-power steering—double-acting bowl jacks—hydraulic forced ejection and highest apron lift* can do for your production. Try any one of 3 models from 10 to 30 yards. See for yourself. Allis-Chalmers, Construction Machinery Division, Milwaukee 1, Wisconsin.

KON-TORK is an Allis-Chalmers trademark.



ALLIS-CHALMERS

...power for a growing world

Some Ideas

for your file of practical information on graph papers

KEUFFEL & ESSER CO.

A graph can be defined as: "A picture of a collection of facts." Often, like that well known Chinese watercolor, a graph is worth a thousand words – or figures. There's no question that graphs speed up comprehension. In some cases, no other way exists to show the subtle interaction of statistics and data except by graph. It's no wonder that legions of engineers, architects, scientists and businessmen rely on graphs and charts to give them the complete information they need.

The big wonder is that more don't know and take full advantage of the fabulous variety of graph papers available from K&E. This is sort of a crusade with us – and has been ever since the turn of the century (a *billion plus* graph sheets ago).

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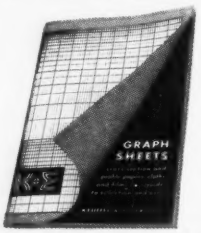
What *is* the graph paper that will do the best job for you? (Actually, there may be more than one – dozens perhaps.) We could answer that here, but we've already done so in a brand new edition of our famed K&E Graph Sheet Catalog. Not only does this catalog guide you in the



selection of the sheets you need, it shows you – often full size, in color – the patterns in question.

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PRINT. Every K&E Graph Sheet ever made was printed from precision-engraved plates by the *letter-press* process. Offset printing, to our way of thinking, relies unduly upon the vigilance and skill of the printer. Variation from lot to lot is a distinct possibility. We have never taken that chance . . . and we're the *only* manufacturer of graph papers that hasn't.

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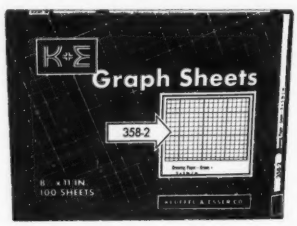

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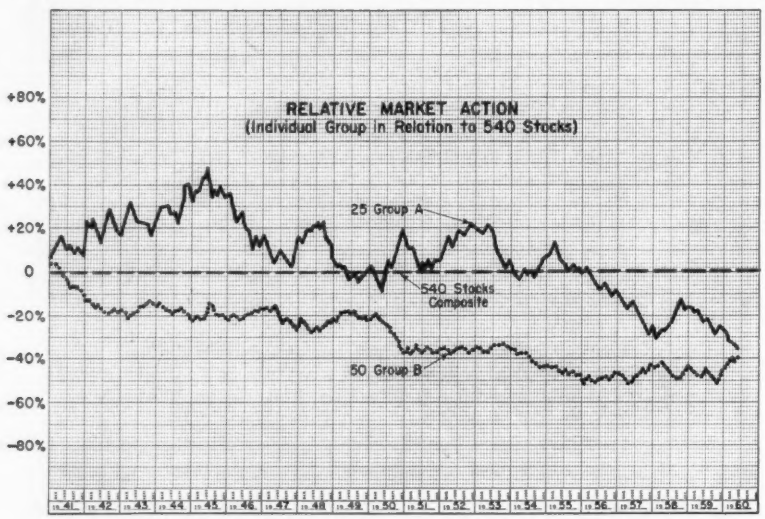

12,300 variables at a glance. Here's a typical stock market chart used to study relative market action. Center line is market behavior of 540 stocks over 20-year period. Two basic stock groups of 25 and 50 individual stocks, averaged, are plotted against market (figured at zero per cent). Resultant chart shows all-important slope of curve which – far more than gross increases – tells the story of the stocks' vitality. No list of statistics, no matter how exhaustive, could give the relative interactions shown here. This picture is possible only with a graph.

But if we don't have what you want – if we lose that 1000 to 1 bet – we'll gladly pay off by working with you to create exactly what you need. We've done this thousands of times for other customers. Just recently it was the U.S. Bureau of Standards. We worked with them to devise two new sheets for recording the complex heat reaction patterns of various insulating materials. These two sheets are already "standards" in the electrical industry.

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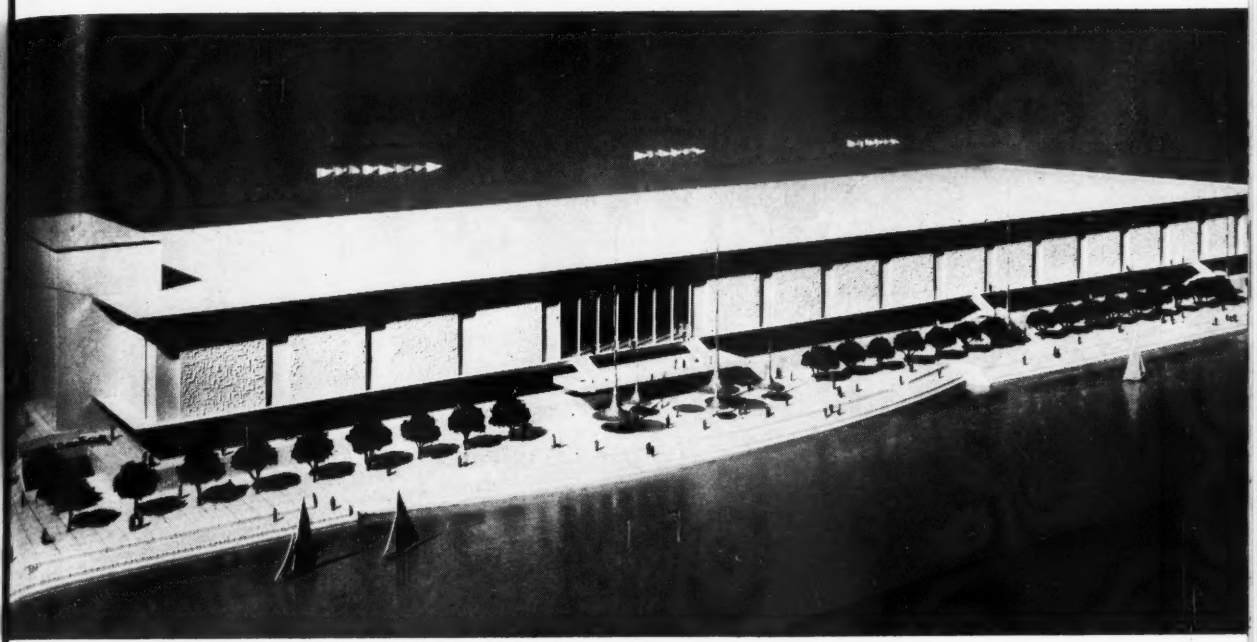
McCormick Place, Chicago's Fabulous Exhibition Center



—from piling to finished steel in 18 months

The first steel piles for Chicago's $34 million Exposition Center were delivered by United States Steel in October, 1958. Eighteen months later, on March 24, 1960, the last big steel beam was set in place. This gives you an idea of how fast a job moves when it's designed in steel.

This mammoth Exposition Center fulfills a dream of the late Colonel Robert R. McCormick. Three decades ago, he envisioned such a structure on Chicago's lake front. The main building encloses an area larger than six football fields. The height will vary from 40 feet to that of a 10-story building.

USS United States Steel

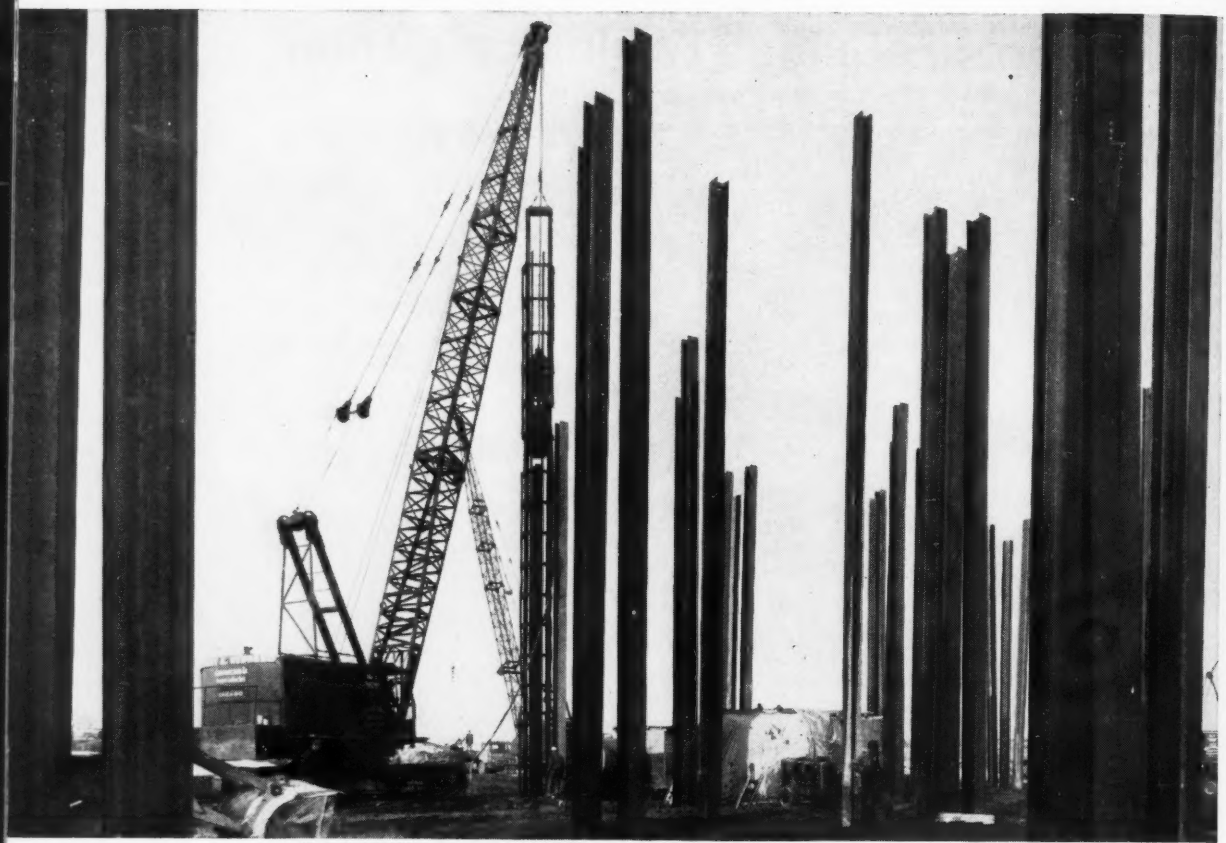
McCormick Place, Chicago's $34 million Exposition Center

Chief Architect: Alfred Shaw, Shaw, Metz and Associates. **Consultants:** John Root, Holabird & Root; Victor Hofer of Ralph H. Burke, Inc.; and Edward D. Stone. **General Contractor:** Gust K. Newberg Construction Co. **Structural Fabrication and Erector:** American Bridge Division of United States Steel. **Owner:** Metropolitan Fair and Exposition Authority. **Chairman:** David Mayer, Jr. **General Manager:** Edward J. Lee. **Piling Contractor:** Lake States Engineering Corporation, Chicago.

SEE NEXT TWO PAGES .....

Used in McCormick Place...

7,024 tons of USS Steel Piling and



Firm foundation. Clusters of 5 USS H-Piles driven 80 feet deep, capped in concrete to form building column foundations.

USS Steel Sheet Piling delivered to the site in October, 1958, for a bulkhead to straighten the shore line and reclaim valuable land from Lake Michigan.

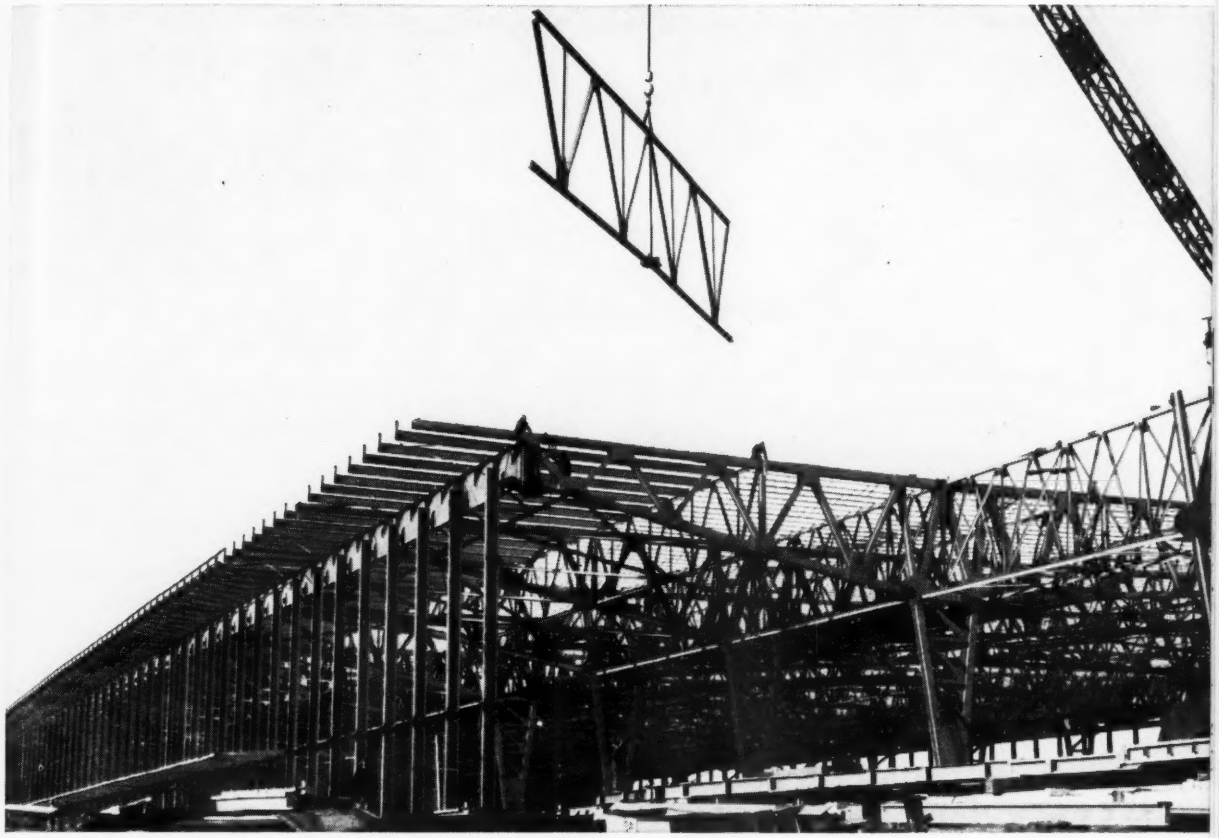
Piling—Before the main building could be started, about five acres of land had to be reclaimed from Lake Michigan. This was done by building a 1,100-foot seawall with steel sheet piling and filling in with more than 100,000 cubic yards of rock, sand and other materials.

The building column foundations consist of 480 clusters of five steel H-Piles each, driven 80 feet deep to bedrock. Altogether, United States Steel furnished 1,073 tons of USS Steel Sheet Piling and 5,951 tons of USS Steel H-Piles for the job. All were delivered on time.

Watch United States Steel's special Christmas show, **The Coming of Christ**, in Color on NBC-TV, Wednesday, December 21, 8:30 P.M., E.S.T.

because it's strong
because it's durable

7,000 tons of USS Structural Steel

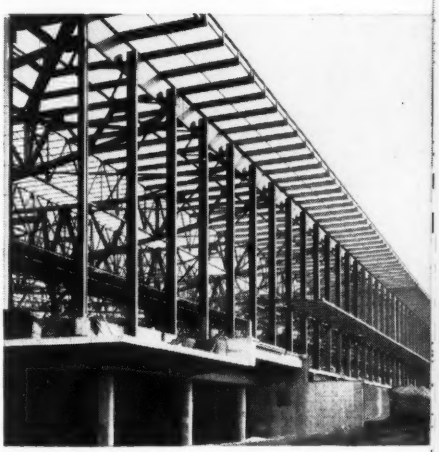


Fast erection. Structural Steel for this 1,180′ x 365′ building went up in four months. It contains 300,000 square feet of exhibit space, a 5,000-seat theater, and can handle three conventions at one time.

Structural Steel—Once the foundations were in, the structural steel for the huge building went up in four months! Considering the overall size of the structure, 365 x 1,180 feet, this was a tremendous achievement. The average height is about 40 feet, except at the south end which houses a theater section as high as a 10-story building.

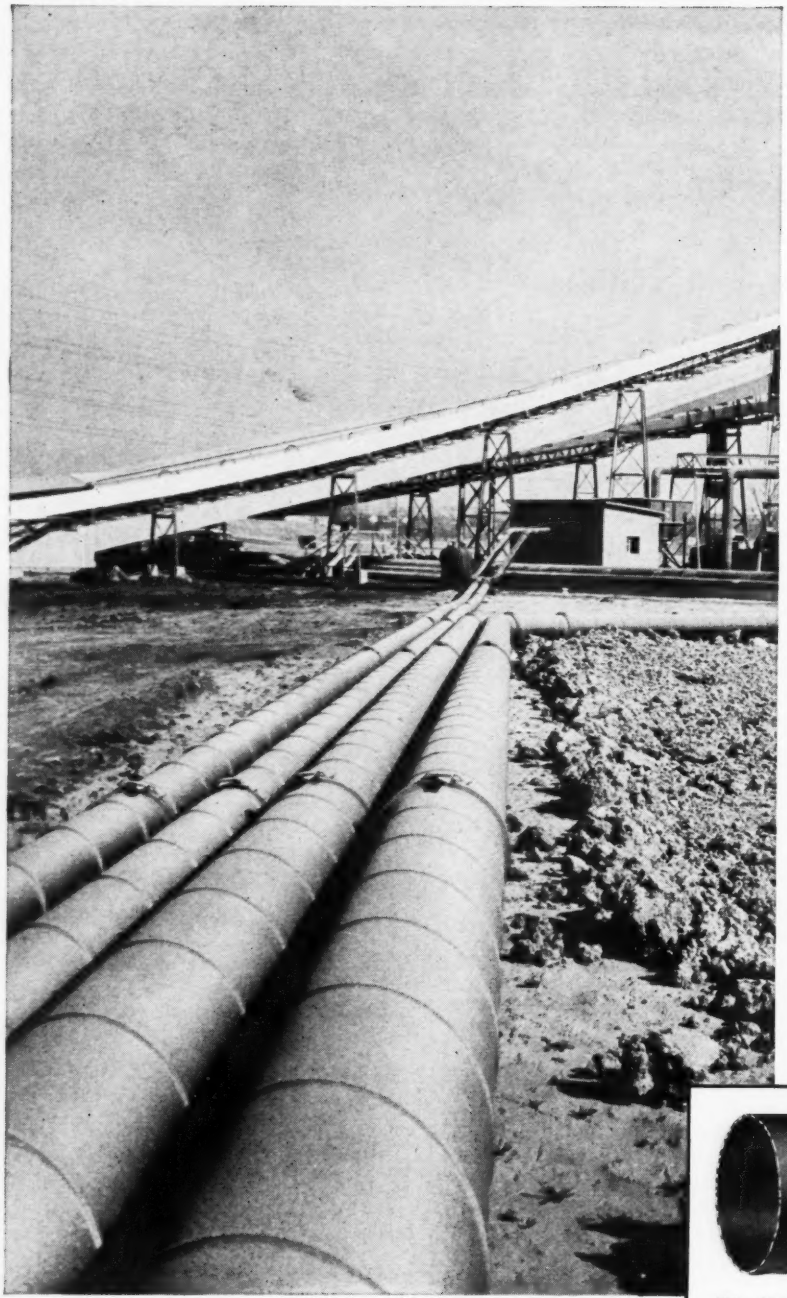
The roof of the exhibition hall is carried on 18 cantilever trusses spaced 60 feet apart. Each truss has a 210-foot central span and 65-foot cantilever arms.

Approximately 7,000 tons of structural steel, most of it rolled at United States Steel's South Works in Chicago, were used to make the mammoth frame. The bulk of this steel was fabricated at another U. S. Steel facility in the Chicago area—the Gary, Indiana, plant of American Bridge Division. In addition, thousands of tons of steel were used for reinforcing bars, welded wire fabric and USS Multigrip Floor Plate. McCormick Place is an outstanding example of the growth and progress that is taking place all over America. *USS is a registered trademark*



United States Steel Corporation—Pittsburgh
American Steel & Wire—Cleveland
Columbia-Geneva Steel—San Francisco
National Tube—Pittsburgh
Tennessee Coal & Iron—Fairfield, Alabama
United States Steel Export Company

United States Steel



They Add Up to SAVINGS!

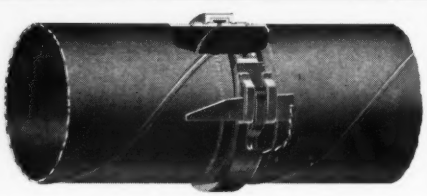
NAYLOR Spiralweld pipe and Wedgelock couplings offer you a combination that can save you time, work and money on lines in construction service.

Any way you look at it, the light weight of NAYLOR pipe makes for easier handling . . . faster installation. And, thanks to the distinctive NAYLOR lockseamed-spiralwelded structure, there's no sacrifice of strength and safety in the line.

Wedgelock couplings contribute to savings by simplifying and speeding connections. A hammer is the only tool required to connect or disconnect them.

That's why it will pay you to consider the performance of this pipe and coupling combination for your lines in air, water and ventilating service.

To get details, write for Bulletin No. 59 today!



The NAYLOR Wedgelock coupling makes a positive connection, securely anchored in standard weight grooved ends.

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Comparison study of Cat DW21G Tractor with SynchroTouch Transmission Control shows

DW21 SERIES G HAULING COSTS ...32% lower than Tractor X ...16% lower than DW21 Series C

Results on the job are the only true measure of a machine's ability to produce *profitably*. Competing on an actual job under identical conditions against Tractor X and a DW21 Series C, the new Caterpillar DW21 Series G-470B team hauled dirt at lowest cost per cu. yd. The combination of SynchroTouch Transmission Control on the tractor and LOWBOWL design of the scraper is unbeatable—note the results below. Your Caterpillar Dealer has a complete report on this job as well as other revealing time-and-cost studies. Ask him to show them to you. See for yourself how the DW21G-470B can step up your profits!

Caterpillar Tractor Co., General Offices, Peoria, Ill., U.S.A.

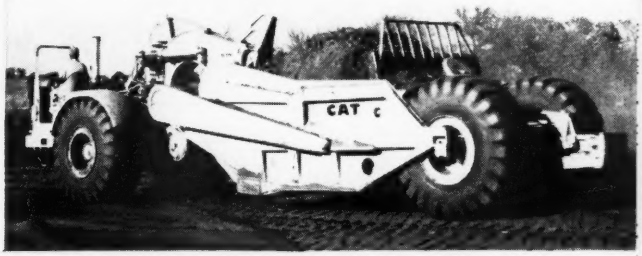
• • • •

PROJECT: South End Shopping Center, Tukwila, Wash. **PURPOSE OF STUDY:** To compare production and cost per yard of equipment observed. **EQUIPMENT:** One DW21G with SynchroTouch Transmission Control; two Tractor X (24-yd. struck, plus 36-inch sideboards); and three DW21C (18 yd. struck). **JOB CONDITIONS: Material**—slightly damp clay with some sand. **Density**—3425 lb./bank cu. yd., average of three tests, oil method. **Haul length**—1300 ft. (one way), return same route. **Haul road conditions**—soft, not maintained during study. **Weight test**—loads weighed with Streeter-Amet Electronic Scales. **Pusher**—all units pushloaded by D9 with Torque Converter Drive.

JOB DATA:	Cat DW21G w/SynchroTouch	Cat DW21C	Tractor X
Average Load Time	.73	.75	1.20
Average Haul, Dump and Return Time	4.14	4.67	4.25
Average Wait Time	.44	.44	.44
Average Cycle Time	5.31	5.86	5.89
Average Payload in Bank Yards	20.0	17.5	23.9
Trips per Hour	11.3	10.0	10.0
Average Hourly Prod. (bank cu. yd.)	226	175	239
Owning and Operating Costs per Hour*	$20.37	$18.87	$31.84
Cost per Yard	9¢	10.8¢	13.3¢

*Hauling costs only—does not include pusher costs

FIELD ENGINEERS WEIGHED LOAD AFTER LOAD as the competing units passed over the portable Streeter-Amet Electronic Scale. By subtracting average empty weight from average gross weight, they determined the average net load weight. This and other job studies prove that the new DW21G-470B hauls dirt at lowest cost per cu. yd., regardless of capacity of competing scrapers.



NEW CAT DW21G TRACTOR-470B LOWBOWL SCRAPER. New Turbocharged 345 HP Cat Engine delivers 12% higher rimpull giving up to 20% faster travel speeds under similar haul conditions than the previous model. With SynchroTouch Transmission Control (optional), operator simply dials desired gear for automatic, split-second, touch-and-go response. New 470B LOWBOWL Scraper is rated at 19.5 cu. yd. struck; 27 cu. yd. heaped. LOWBOWL design loads more material faster because of less loading resistance. Result: DW21G-470B moves dirt at lowest cost per cu. yd.

CATERPILLAR

Caterpillar and Cat are Registered Trademarks of Caterpillar Tractor Co.

HAUL AT LOW COST PER CU. YD. WITH A DW21G-470B

Built for Michigan State Highway Department.

Double-deck triple-lift bridge keeps traffic moving over Portage Lake

The new Portage Lake Bridge, linking Houghton and Hancock in Michigan's upper peninsula, is one of the heaviest lift bridges ever built. It takes the place of an obsolete double-deck swing span erected in 1895. Hazelet and Erdal, Consulting Engineers, designed the bridge to operate on three levels. When the lake is frozen, the lower position, 7′ above water, carries railroad traffic on the lower deck and automotive traffic on the upper. When the lake is open, the span is stationed at 32′ to accommodate passage of small pleasure craft while maintaining auto traffic on the lower deck, and lowered only to handle trains. The third position is at 135′, to accommodate the largest Great Lakes ships.□The bridge has 6 girder approach spans ranging from 83′10″ to 113′ and two truss spans 119′6″ long. A vertical lift span, 150′ long and weighing 2,200 tons, carries two 26′ roadways on the upper deck and a single-track railroad on the lower, plus one simple beam span and five simple girder spans on each side. Total amount of steel used: 7,365 tons, fabricated and erected by American Bridge. Write for information on our construction services, or phone the sales office nearest you.

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This mark tells you a product is made of modern, dependable Steel.

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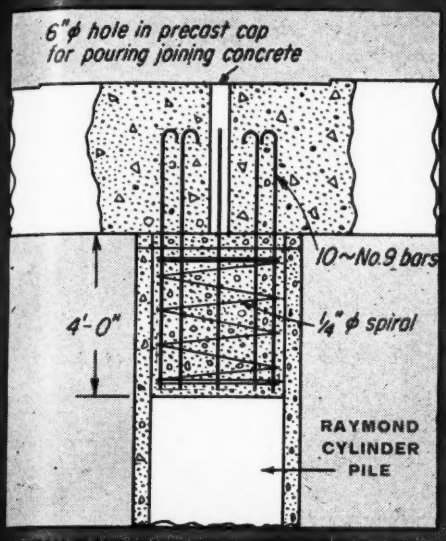
American Bridge Division of United States Steel

Watch United States Steel's special Christmas show, **The Coming of Christ**, in Color on NBC-TV, Wednesday, December 21, 8:30 P.M., E.S.T.



HOW RAYMOND PRESTRESSED PILES ARE TIED TO PRECAST CAP

PONTCHARTRAIN TO PENSACOLA:

RAYMOND and the case of the traveling bridge

From an assembly line two hundred miles away thousands of Raymond prestressed concrete cylinder piles were floated to the site of the new $8,000,000 Pensacola Bay Bridge.

Because of tricky bottom conditions many of the 54-inch Raymond piles—enough to support about 3,000 feet of the bridge—were built to a length of 164 feet, quite probably the longest ever used for a bridge in this country. The precast, pre-stressed deck slabs reach a span of 60 feet and weigh about 150 tons apiece, providing twin roadways, each 26 feet wide.

Much time, meaning much money, was saved by using these post-tensioned Raymond piles, even though they had to be barged for 200 miles from the yard in Mandeville, La. Incidentally, this yard was set up originally to fabricate the same type of Raymond pile for the magnificent Lake Pontchartrain Causeway.

It is this quality, derived from long experience and creative engineering ability, that Raymond offers as stock-in-trade. Foundations often present unusual problems and we are equipped to handle most of them, however large or small, on land or under water. May we be of help to you? Just call or drop a line to any of the Raymond offices here or abroad.

DESIGN AND SUPERVISION: Engineering Staff, Florida State Road Dept. CONTRACTORS: a joint venture of Brown & Root and T. L. James, Inc.

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U.S. cast iron PIPE FOR WATER, SEWERAGE AN

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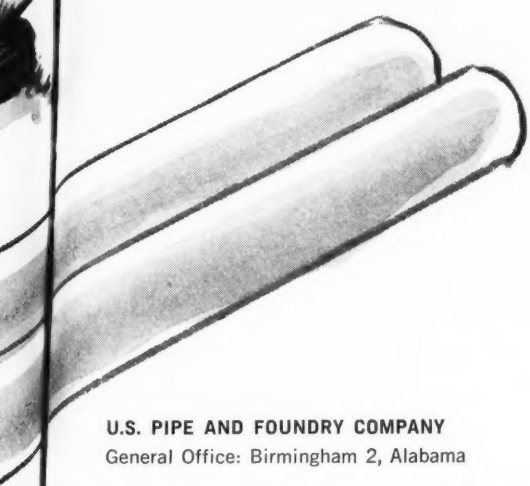

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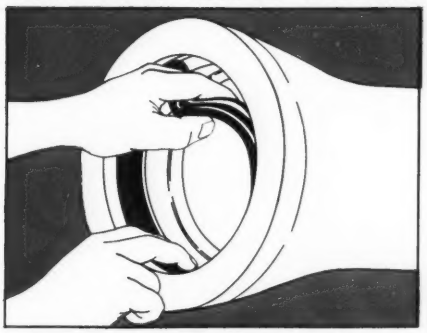
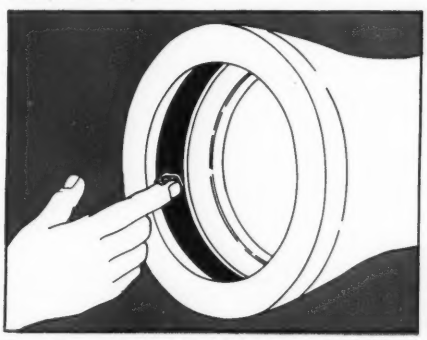
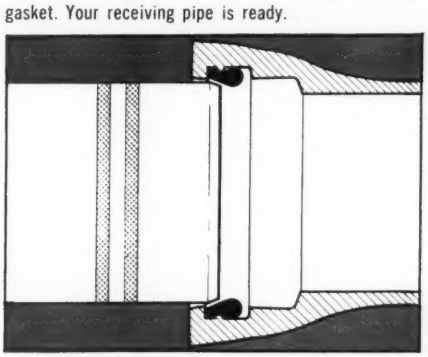


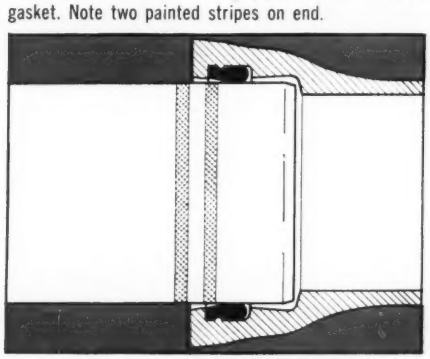
Insert gasket with groove over bead in gasket seat . . . a simple hand operation.



Wipe film of Tyton Joint® lubricant over inside of gasket. Your receiving pipe is ready.



Insert plain end of entering pipe until it touches gasket. Note two painted stripes on end.



Push entering pipe until the first painted stripe disappears and the second stripe is approximately flush with bell face. The joint is sealed . . . bottle-tight, permanently! The job's done . . . . fast, efficiently, economically. Could anything be simpler?

In closing months, 99 trucks ran night and day to reach a goal of 17 million miles over test loops

683 times "around the
it's the great

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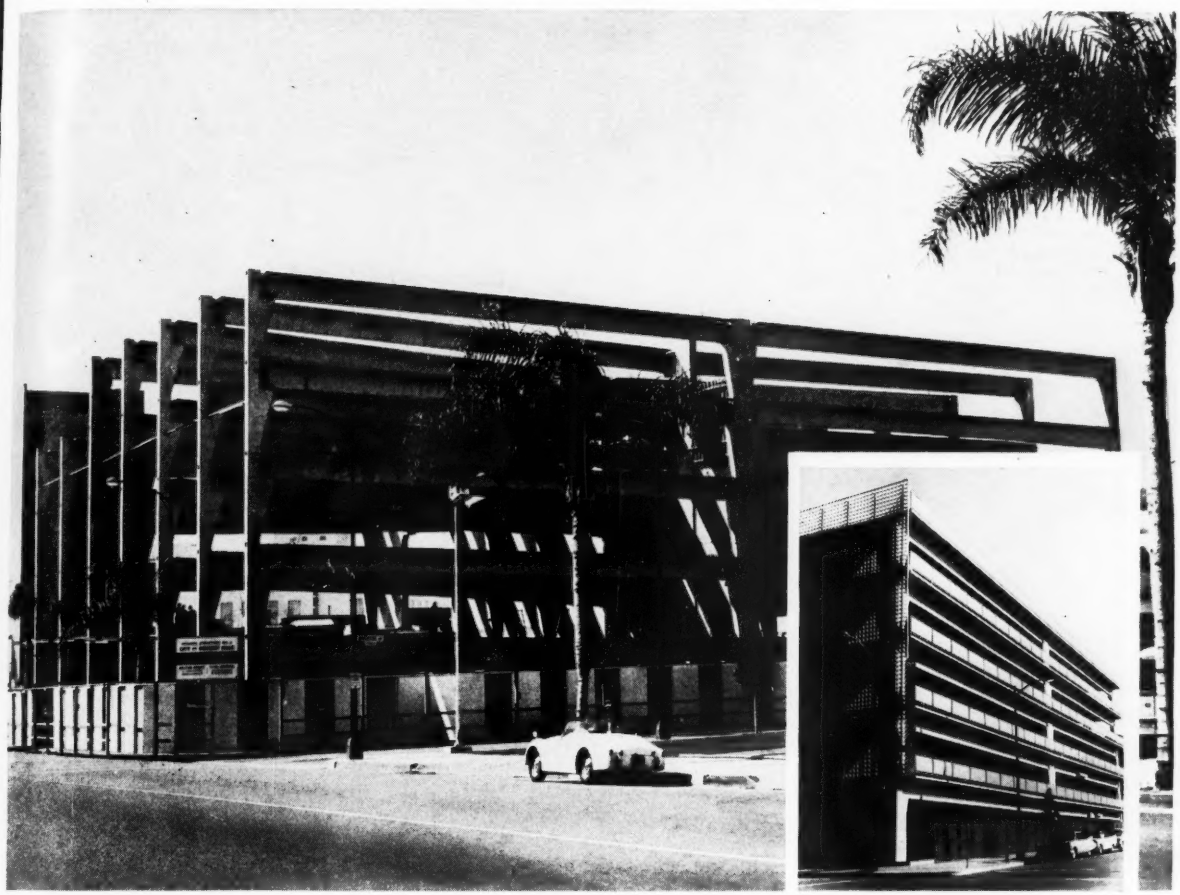

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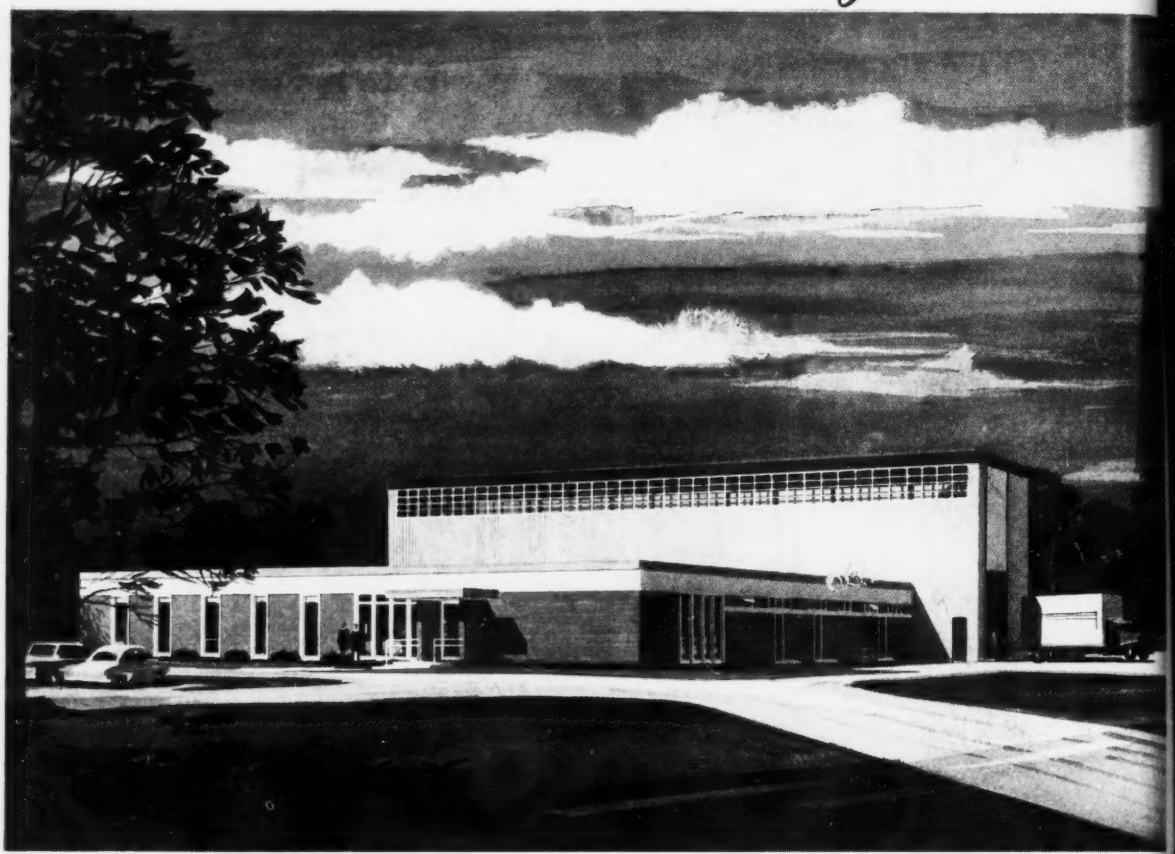

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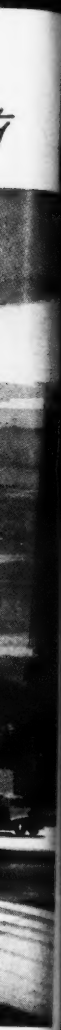

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